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The Mammalian Fauna of Madura Cave, Western Australia
Part II

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INTRODUCTION

This work constitutes Part II of a series of reports on the Madura Cave fauna. It continues the systematic section, Order Marsupicarnivora, begun in Part I (Lundelius and Turnbull, 1973). Included are accounts of the Madura Cave representatives of the genera *Sminthopsis* and *Antechinomys*.

The lack of detailed description and illustration of the dentitions of most living taxa of Marsupicarnivora severely hampers paleontological study. To remedy this situation, we have continued the procedure initiated in Part I of describing and illustrating the dentitions of certain of the living species, as well as those of the Madura fossils. The description of the remainder of the fauna, analysis of its composition, and the paleoenvironmental and zoogeographic implications will be dealt with in subsequent parts of this volume.

Section I dealt with the regional setting of the cave, the stratigraphy of the deposits, the C-14 dates, and the small phascogaline allied to *Planigale* or *Antechinus maculatus*. Thus far,

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none of the four taxa described (*Sminthopsis crassicaudata, S. murina,* and *Antechinomys spenceri* treated below, and the *Planigale*-like form of Part I) show any significant evolutionary change throughout the sequence. Small sample size of all taxa except *A. spenceri* rule out the chances of our being able to detect small changes if they do exist.

Abbreviations, measurements, and tooth element terminology are either those in standard usage or they follow the form and procedures given in the methods section of Part I, unless otherwise noted.

SYSTEMATICS

Class Mammalia

Subclass Theria

Infraclass Eutheria (Sensu VandeBroek, 1961, 1964)

Cohort Marsupiata (Sensu Turnbull, 1971; = Metatheria)

Order Marsupicarnivora (Ride, 1964)

Dasyuridae

Phascogalinae

The Madura Cave fauna contains several other phascogales in addition to the minute, indeterminate form of pygmy antechinus near *Planigale ingrami* and *Antechinus maculatus* treated in Part I. These are (*1*) a complex of three small species (treated here) currently put into the genera *Sminthopsis* and *Antechinomys*, which are so similar in size, proportions, and dental morphology that separation of their skeletal and dental remains is exceedingly difficult, and (*2*) six species belonging to the genera *Antechinus, Phascogale, Parantechinus, Dasycercus,* and *Dasyuroides.*

Generic separation of *Sminthopsis* and *Antechinomys* on the basis of cranial features rests largely upon differences in degree of development of the auditory bulla (larger in *Antechinomys*) and the following characteristics of the mandibles (fig. 1). In *Sminthopsis* the masseteric fossa is broad and flares upwards, the condyle is relatively low (only slightly raised above the occlusal area of the dental battery), and the angular process, while elongated and arched, is relatively less developed, so that its tip and the tip of the coronoid process are about equidistant from the condyle. In *Antechinomys* the ascending ramus has a more horizontal inclination (about 60° to occlusal plane in contrast to about 70° in *Sminthopsis*), the masseteric fossa is narrow, and its front and back

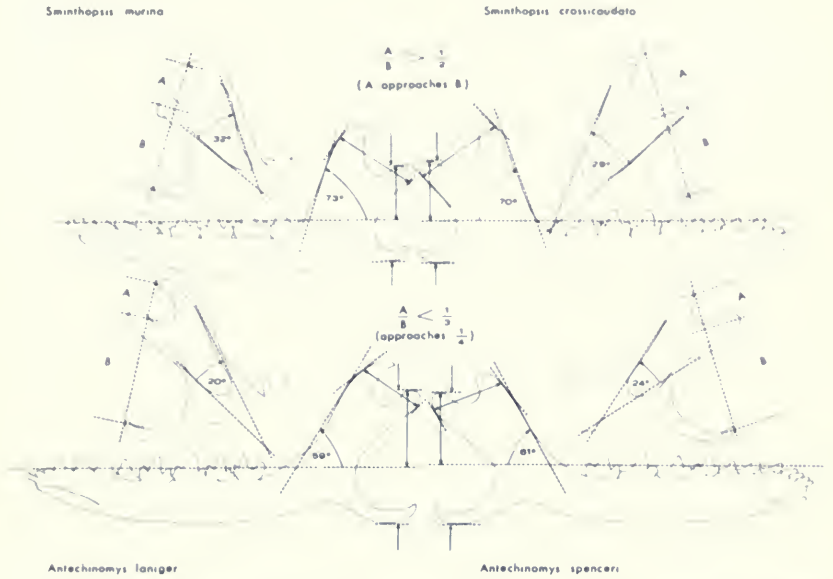


FIG. 1. Outline drawings of medial views of mandibles of two of the living species of *Sminthopsis* (above), and of the two species of *Antechinomys* (below). Inserts show the lateral views of angle and ascending ramus of each. Compare: (*1*) breadth of the ascending ramus, broad in *Sminthopsis,* narrow in *Antechinomys* (see the oblique arrows and spread angle of the fossae); (*2*) height of the condyle above the occlusal area of the cheek teeth (proportionally higher in *Antechinomys* than in *Sminthopsis*; posterior-most vertical arrows); and (*3*) ratio of A = distance from condyle to tip of coronoid process, to B = distance from condyle to tip of angle. (A/B is $>$ ½ and approaches 1/1 in *Sminthopsis* while in *Antechinomys* A/B $<$ ⅓ and approaches ¼). The extent of expansion of the angular process is emphasized by the other set of vertical arrows.

edges are nearly parallel; the condyle is high absolutely and relative to the tooth row; and the angle is delicately built, highly arched, and attenuated to accommodate the large bulla of this genus, and thus its tip is much farther removed from the condyle than is the tip of the coronoid process. On dental criteria alone, generic separation of *Sminthopsis* and *Antechinomys* is more obscure.

Within the genus *Sminthopsis*, two groups[1] can be recognized on the basis of the lower molars. In one of these, here designated

[1]These groups merely comprise species that have in common one condition of entoconid form and development. They are not meant to be formal taxonomic groups for they are presently based upon only this one character, but this is not to deny that they may have taxonomic implications.

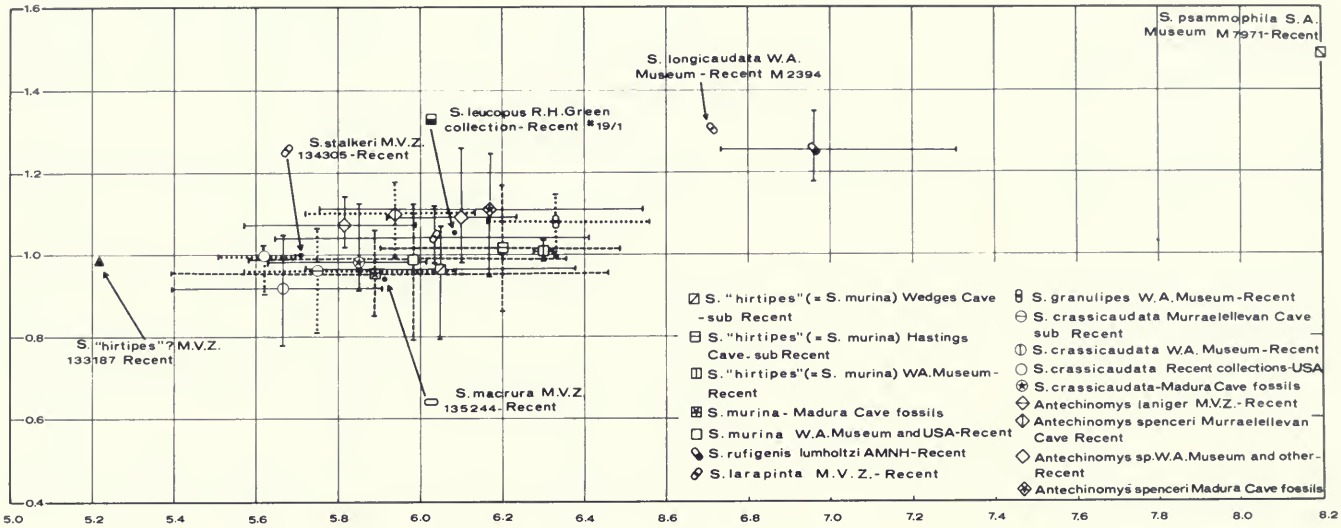


FIG. 2. Bivariate graph giving length of the lower molar series (abscissa) × length of P_4 (ordinate) as a means of comparing various samples of *Sminthopsis crassicaudata* and *S. murina* with one another and with samples of other species of *Sminthopsis* and *Antechinomys*. The graph is an extension of Figure 13 of Part I of the Madura Cave fauna, and thus there is easy and direct comparison with the three taxa shown there. Measurements are given in mm.

Species represented by a single specimen are named directly on the graph, with catalogue number and source. Those taxa listed by symbol in the key all represent series of specimens whose ranges and means are shown on the graph. For them sample size and specimen numbers are given in Appendix 1.

group A (comprised of *S. crassicaudata, S. macrura, S. rufigenis, S. stalkeri*, and *S. larapinta*), each of the lower molar teeth excepting M_4 possesses a well-developed, usually high columnar entoconid as a characteristic feature. In the other, group B (comprised of *S. murina, S. hirtipes, S. psammophilla, S. leucopus, S. longicaudata*, and *S. granulipes*), the lower molars either lack entoconids entirely, or, if present, they are small to minute and low, usually anteroposteriorly enlongated. According to Archer (pers. comm.), *Sminthopsis murina* shows greater variation in the development of the entoconids than we have observed, but, in general, its entoconids are not as large as those of the species within group A. In both groups the crest from the hypoconid (post-metacristid or I″) extends far lingually then swings sharply posteriorly to join the hypoconulid. In group A it runs onto the side, or at least the base, of the entoconid before it turns toward the hypoconulid, and with wear becomes joined to the entoconid. In group B there is no entoconid-postmetacristid fusion, even when entoconids are relatively well formed; instead there is usually a low subsidiary diagonal ridge that runs into the center of the talonid basin from the point of flexure of the postmetacristid toward the hypoconulid, and this ridge may even become somewhat accentuated by wear. Unfortunately for the worker confined to teeth, these lower molar features of group B are all found also in the lower molars of species of *Antechinomys*.

For the upper dentition there is no parallel dichotomy based upon such a clearcut discrete feature as entoconid development of the lower molars; instead, we have only subtle proportion differences without clear-cut separations.

At the species level, both within the genus *Antechinomys* and within the two species groups of *Sminthopsis*, size and dental proportions of the lower teeth serve to distinguish some species (figs. 2, 3, 4, tables 1-15). For *Antechinomys*, dental proportions of the living *A. spenceri* and those of *A. laniger* differ from one another only slightly (fig. 4). The Madura fossil representatives of this genus also differ slightly from both of the living species, but they show a closer affinity to *A. spenceri* than to *A. laniger*. For species within group A, *S. crassicaudata* is the smallest, and thereby separable. For the species within group B, not only are size and dental proportions close, but the lower teeth are very much like those of *Antechinomys*.

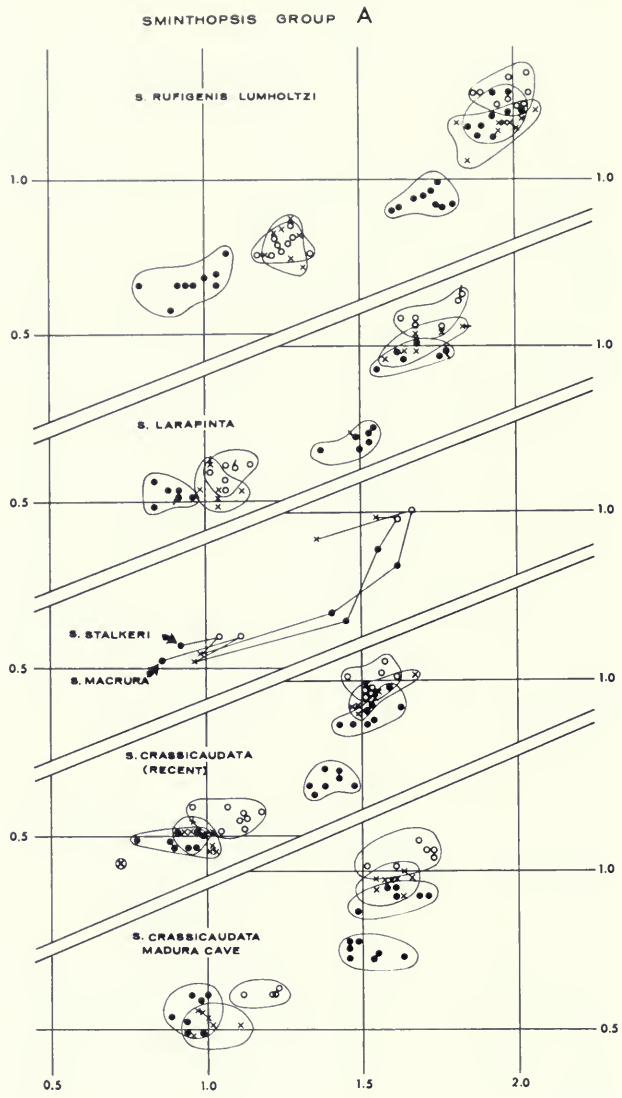


FIG. 3. **A.** Bivariate graphs showing length (abscissa) × anterior width (ordinate; maximum width for the premolars) dimensions of the lower cheek teeth for a series of samples of species in *Sminthopsis* group A. The Madura Cave sample of *Sminthopsis crassicaudata* is shown at the bottom and a Recent sample is just above it. Other related species are shown for comparison. Note both extent of variation for each tooth and the patterns of the series of plots for each taxon as one proceeds from P_2 to M_4 along the series. A key to the symbols is given in Figure 3B. Specimens measured are listed in Appendix 2.

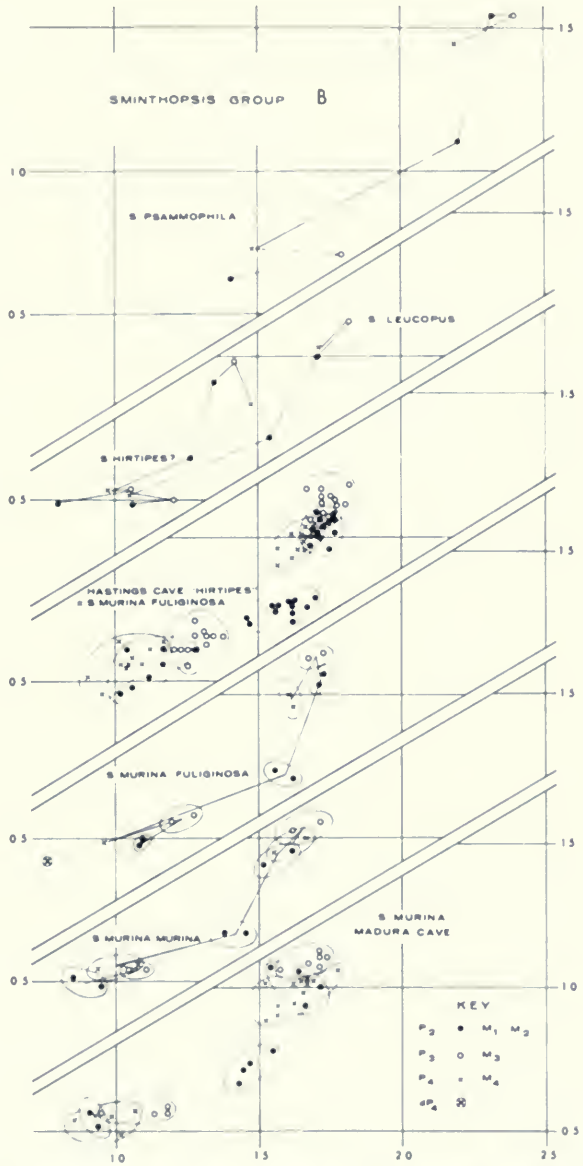


FIG. 3. B. Comparable graphs to those shown in A represent a series of species of *Sminthopsis* group B. The Madura Cave sample of *Sminthopsis murina* is at the bottom and the Recent samples of two of the subspecies of that species are immediately above it. As in A, some other related species are also shown for comparison. Specimens measured are listed in Appendix 3.

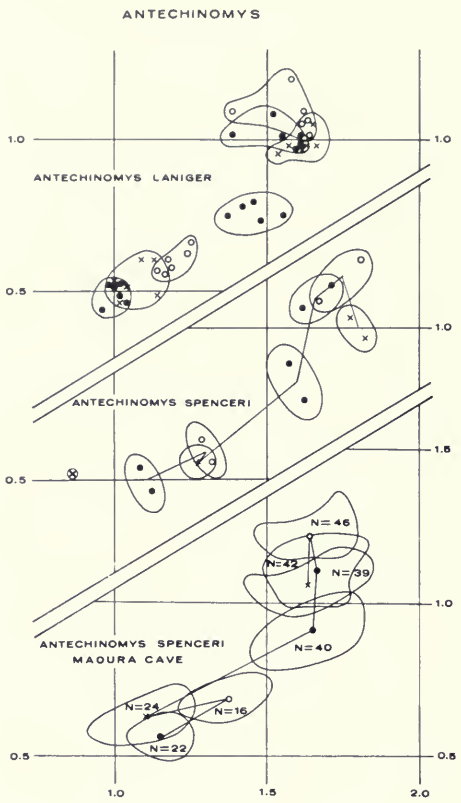


FIG. 4. Bivariate graphs comparable to those of Figure 3 for samples of the two Recent species of *Antechinomys* together with that of the Madura Cave sample (bottom). With the Madura sample the points are not included as there are too many for clarity — instead the clouds are tightly drawn so as to delimit each set of plots and the N for each is given along with the tooth symbol. For key see Figure 3B. Specimens measured are listed in Appendix 4.

The lower teeth of *Sminthopsis murina* and *Antechinomys spenceri* are so similar that were it not for association with discrete osteological differences, such as the shape of the masseteric fossa, their separation would be almost impossible. Some scatter diagrams of measurements of lower molars do show separate groups that correspond with the groups based on the shape of the masseteric fossa in those specimens in which it is known. This permits the assignment of most of the ramal fragments with teeth (but which lack the diagnostic masseteric fossa or any part of the ascending ramus) and possibly even isolated teeth, so that only a small

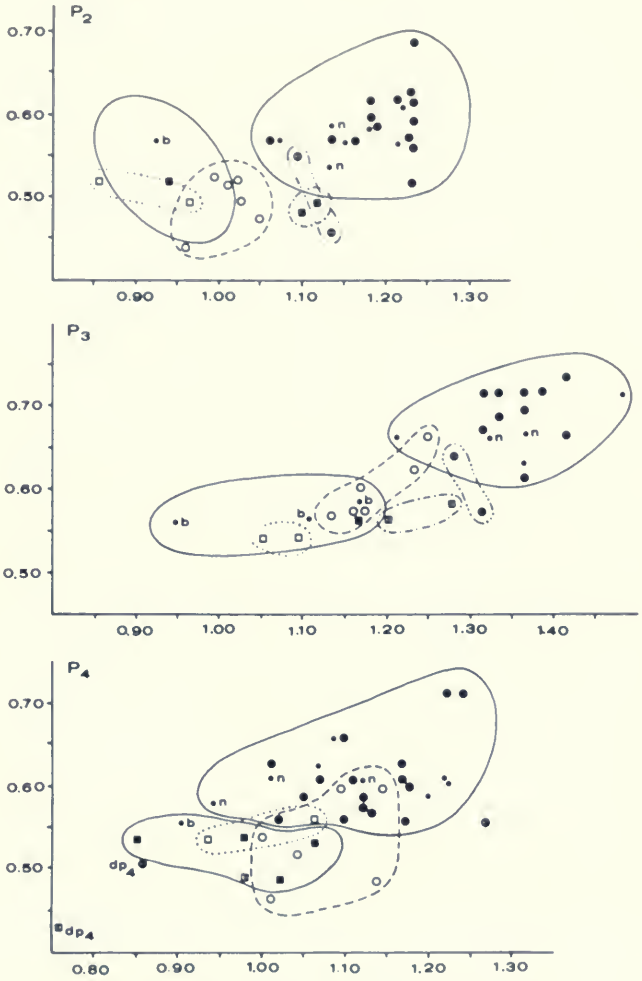


FIG. 5. Bivariate graphs of length (abscissa) × width (ordinate) for each of the lower premolars of the Madura Cave specimens in the *Antechinomys-Sminthopsis murina* group. Teeth in jaws with a broad fossa are shown as filled squares, those in jaws with a narrow fossa are shown as filled circles. Teeth in partial jaws thought to be of broad fossa type are each shown as a dot with a $_b$ subscript, those in partial jaws thought to be narrow fossa type are each shown as a dot with an $_n$ subscript. Very worn teeth are indicated by a dot with a $_w$ subscript. Isolated teeth or those in jaws which do not preserve enough of the angle and ascending ramus for an assessment of the form of the fossa are shown as a dot. Specimens included are listed in Appendix 5.

For comparison, the Recent specimens are also included: open square = *Sminthopsis murina murina*; square with vertical line = *Sminthopsis murina fuliginosa*; open circle = *Antechinomys laniger*; circle with verticle line = *Antechinomys spenceri*. The Recent specimens are listed in Appendices 2-4.

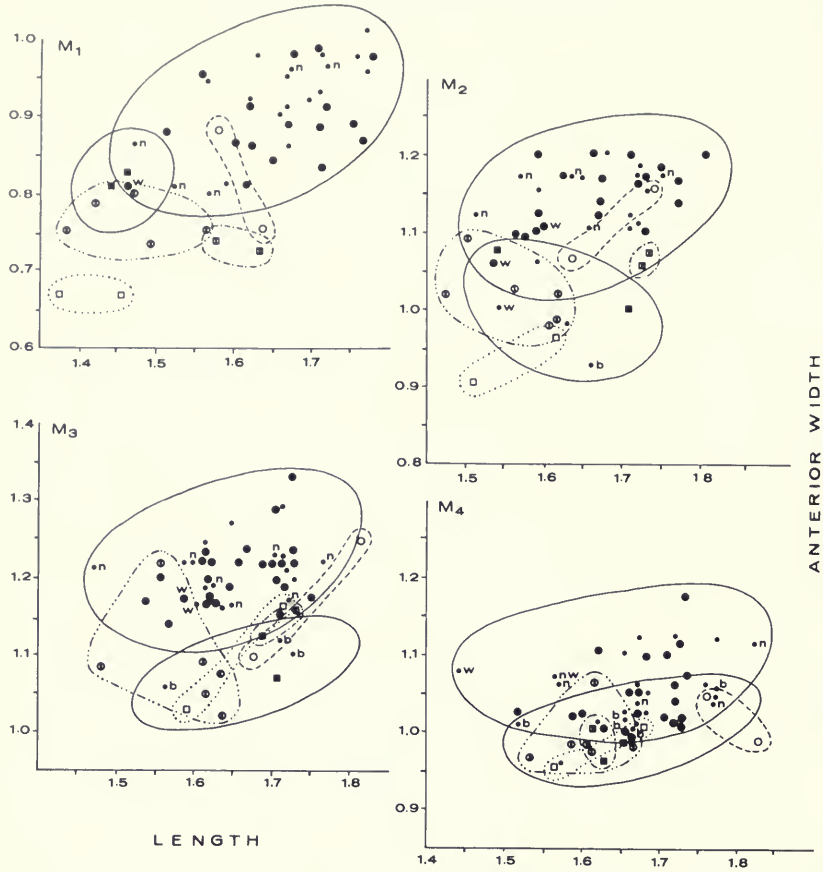


FIG. 6. Bivariate graphs (length × anterior width) for each of the lower molar teeth in the Madura Cave *Antechinomys-Sminthopsis murina* samples. Symbols as in Figure 5. Specimens included are listed in Appendix 6.

proportion of such remains cannot be assigned and must be carried *incertae sedis*. All such assignments depend upon the closeness of fit of the plots of the unknown specimens to those of the modern species and the "known" series of the fossils (see the series of bivariate scatter diagrams on figs. 5, 6, 7). The procedure is as follows:

Scatter diagrams of various pairs of cheek teeth measurements were made of all teeth remaining in mandibles that, because they lack the *crassicaudata*-type of entoconid, are thought to be assignable to either *Antechinomys spenceri* or *Sminthopsis murina* (figs. 5, 6, 7). In each case those associated with a broad masseteric fossa are indicated by a black square. Those associated with a

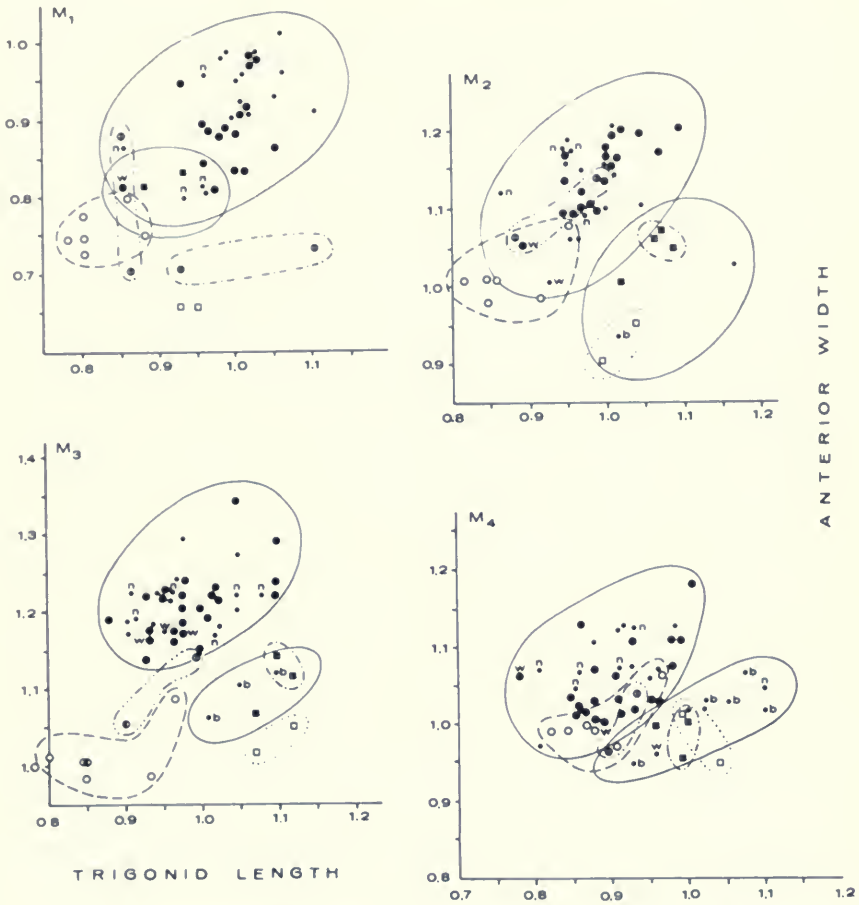


FIG. 7. Bivariate graphs of trigonid length × anterior width (= trigonid width) for each of the lower molar teeth in the Madura Cave *Antechinomys-Sminthopsis murina* samples. Symbols as in Figure 5. Specimens included are listed in Appendix 7.

narrow masseteric fossa are indicated by a black circle. All others are plotted as points, with severely worn teeth further designated by a "w." Teeth in fragmentary mandibles that preserve some evidence of masseteric width and can, therefore, be at least questionably assigned are further indicated by subscripts: n for narrow, b for broad.

Scatter diagrams of length versus width of all premolars associated with molars with the small or absent entoconids from Madura Cave show a tendency to form two groups (fig. 5). When

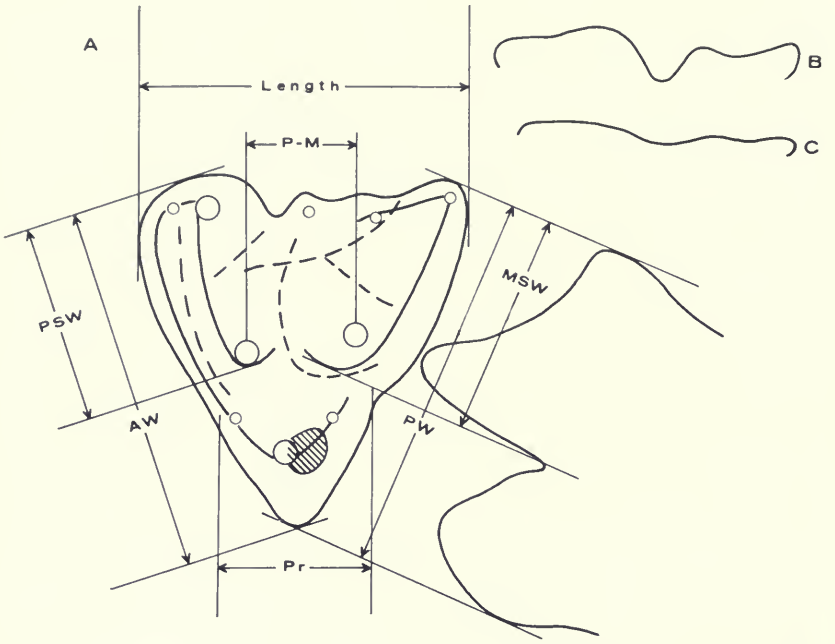


FIG. 8. Diagram of manner of taking upper molar measurements and of detail of the labial border of the ectoloph. **A.** Schematic outline of an upper molar showing measures used. Abbreviations as follows: P-M = paracone-metacone length; Pr = protocone length; A W = anterior width; P W = posterior width; PSW = parastylar width (parastyle-paracone width); MSW = metastylar width (metastyle-metacone width). The "thegosed" wear facet of the protocone of *S. crassicaudata* (see text) is indicated by diagonal hatchure.

B C. The two basic forms of ectoloph margin of M^{2-3}. In the Madura Cave fossils the deeply notched margin (B) characterizes *Sminthopsis,* especially *S. crassicaudata,* and the nearly straight margin (C) characterizes *Antechinomys.*

the specimens in which the ascending ramus is preserved are considered, it is clear that although there is overlap, the premolars of those which can be identified as *Antechinomys* on the basis of narrow masseteric fossae are somewhat larger than those identified as *S. murina* on the basis of broad masseteric fossae.

Scatter diagrams of the length versus anterior width of the lower molars show much the same pattern (fig. 6), but the M_3's and M_4's of *Antechinomys* are proportionately wider than those of *S. murina.*

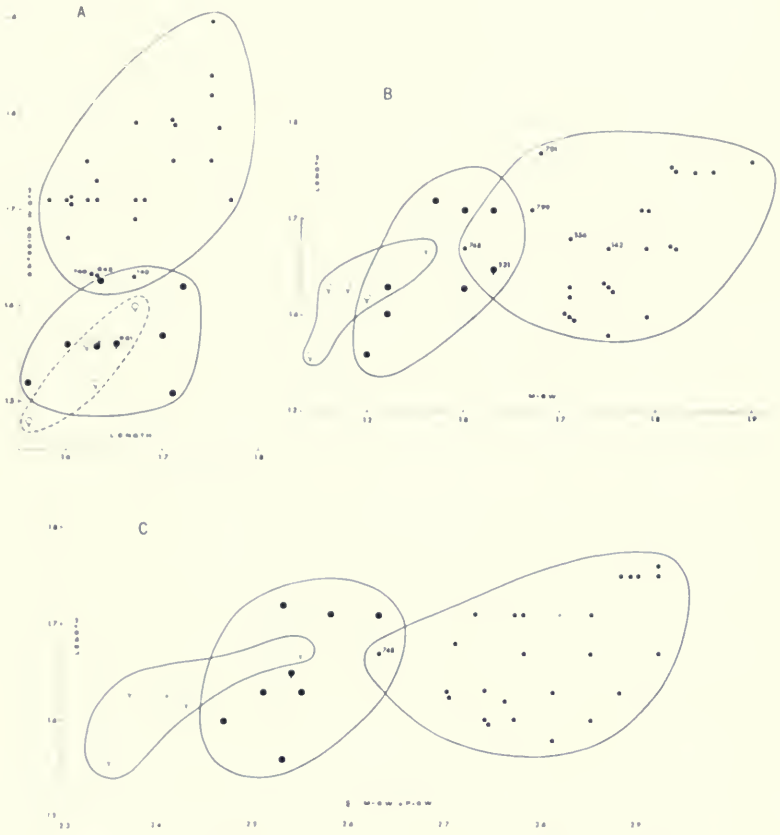


FIG. 9. Three bivariate graphs in which various combinations of measurements of M^2's (in mm.) belonging to animals in the *Sminthopsis-Antechinomys* assemblage from the Madura Cave fauna are given. In each case, the features measured are indicated along the abscissa and ordinate axes. Note that the two *Sminthopsis* species usually overlap one another broadly, but that *Antechinomys*, being slightly larger, only overlaps *S. murina* and the overlap is to a lesser degree. This sort of pattern is repeated in a number of combinations of dental measures, and in a few cases, as seen in Figure 10A, E, there is no zone of overlap between the two genera.

Large circles represent the *Sminthopsis* teeth, dots the *Antechinomys* teeth. Open circles, all of which bear a tail indicative of the presence of a thegosed wear facet on the posterolingual side of the protocone, represent *S. crassicaudata*. Filled circles, which with one exception (531) lack the thegosed facet, represent *S. murina*. The dots represent probable *Antechinomys spenceri*. A few specimens that occasionally, or even repeatedly, are found to plot in the overlap zone between the genera are tagged by their last three catalogue numbers as their assignment may be somewhat less certain. Abbreviations as in Figure 8. Specimens plotted are listed in Appendix 8.

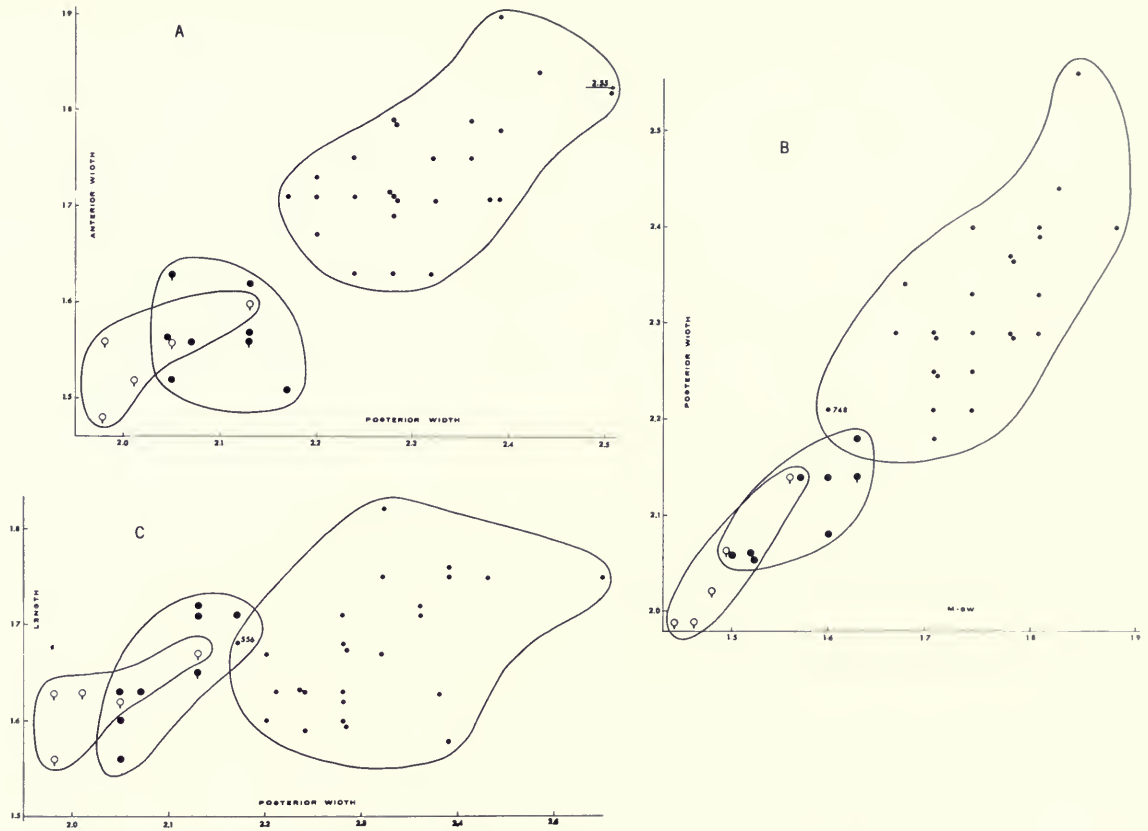


FIG. 10,**A,B,C.** Three bivariate graphs like those shown in Figure 9, giving other measurements of M^2 for the same set of specimens. Symbols as in Figure 9. Specimens listed in Appendix 8.

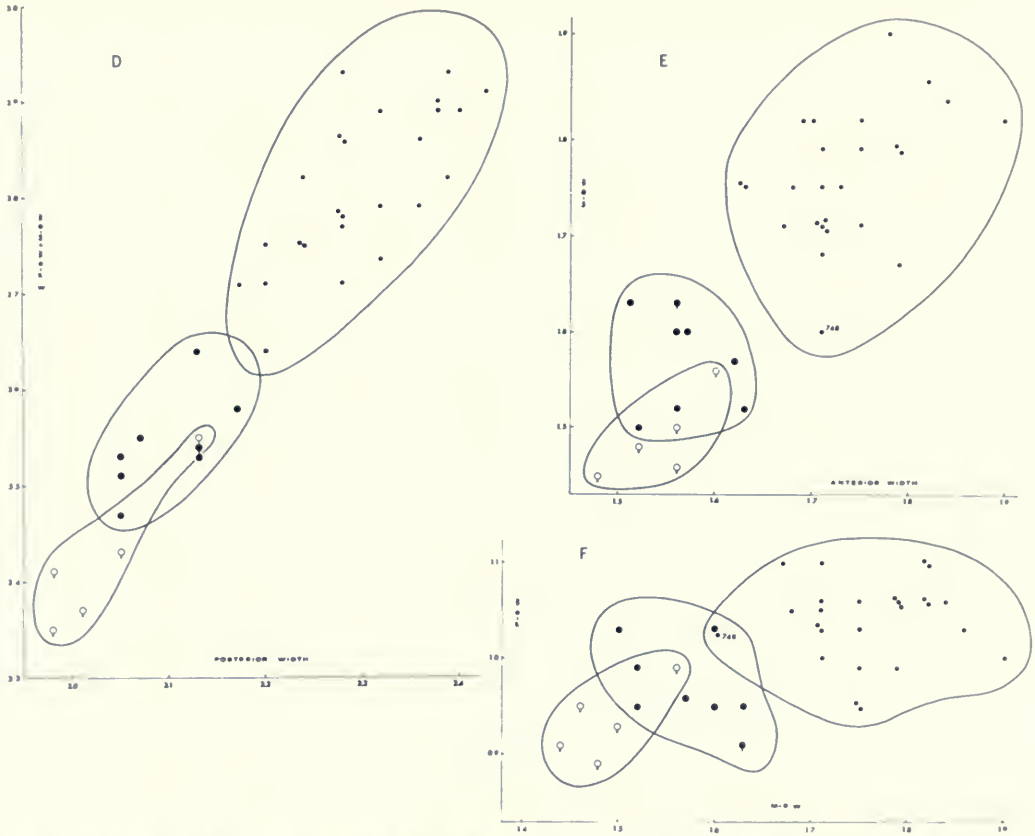


FIG. 10,D,E,F. Three bivariate graphs like those shown in Figure 9, giving other measurements of M^2 for the same set of specimens. Symbols as in Figure 9. Specimens listed in Appendix 8.

Scatter diagrams of lengths of trigonid versus anterior width (=trigonid width) of the molars show that the M_1's of *Antechinomys* are slightly larger than those of *S. murina* (fig. 7). The M_2's, M_3's and M_4's of *Antechinomys* have slightly shorter and wider trigonids than their counterparts in *S. murina*. In the M_3 there is no overlap of the clouds of points of the two species, and the specimens that are not classifiable on the basis of the masseteric fossa fall unequivocally in one or the other of the groups. The scatter diagram of the M_2 shows nearly as clear a separation of the two groups, while those of M_1 and M_4 show considerable overlap.

Identification of upper dentitions and maxillary fragments within this complex of species is even more difficult, for there usually are no such clearcut, discrete structures as columnar entoconids or broad versus narrow masseteric fossae upon which to base identifications. With the Madura teeth, the combination of dental measurements with several somewhat discrete and usually distinguishable features (fig. 8) definitely helps separate the upper teeth of *Sminthopsis* from those of *Antechinomys*. Features that distinguish the genera are (*1*) the detail of the form of the buccal edge of the ectoloph of the upper molars, especially M^3, and (*2*) the size and proportions of the molars (width, symmetry, relative length of the eocrista).

Size and proportions overlap somewhat, but they are consistent enough within the Madura sample that they afford a basis for separating the two genera. In *Sminthopsis*, M^{1-3} are narrower and more symmetrical in respect to protocone position and form of metastylar area than are the counterparts in *Antechinomys* where greater breadth and an anteriorly protruding protocone condition usually makes for fairly easy recognition. Within the available Recent comparative materials, however, neither of these features is as clearcut.

The most consistent proportional differences of both the Recent and fossil samples in the upper molars between *Sminthopsis* and *Antechinomys* are the lengths of the anterior and posterior segments of the eocrista (parastyle-paracone width and metastyle-metacone width) relative to other parts of the teeth. In the upper molars of *Antechinomys* these two segments are longer relative to other dimensions of the teeth than in *Sminthopsis*. This is clearly shown in a number of scatter diagrams that involve these characters (figs. 9, 10). The elongation of these parts of the eocrista

is correlated functionally with the relatively wider trigonids in the lower molars of *Antechinomys*.

The form of the buccal edge of the ectoloph also appears to be consistent for the Madura materials. Within the Madura sample there are two basic forms of margin (fig. 8b, c) that correspond to the two genera as here differentiated. These do not hold for the Recent materials of these same taxa in which the condition is variable or may even be reversed. This disconcerting apparent inconsistency may be explained by the nature of the sampling of both the Recent and fossil materials. The variable Recent samples of each species are composed of specimens drawn from discrete remote local populations, while those with consistent patterns are from single local populations in which one or the other variant of this morphologic feature appears to have been selected for. The Madura fossils represent a single local fauna, and it appears that the taxa considered here have maintained their local morphologic identities throughout the 30,000-year time span represented by the specimens.

The species assignment of the upper molars of the *Sminthopsis* materials is a much more difficult problem. As is shown in Figure 2, Recent specimens of *Sminthopsis crassicaudata* are smaller than other species of *Sminthopsis*. Presumably the same relationship holds in the Madura fossils. Also the presence or absence of a peculiar sort of facet[1] in some ways similar to a thegosis-type of wear facet (Every and Kühne, 1970) on the posterolingual side of the protocone of M^{1-3} suggests another means of separating the two species. This wear facet, as in thegosis facets, has parallel microstriae which result from contact with the well-developed entoconid of the opposing lower molar. Such "thegosed" facets are present on the Recent specimens of *S. crassicaudata* if the individual is old enough to show wear elsewhere in the dentition. Unfortunately, some attrition may also be caused by the food, causing the facet to be variably formed. Older specimens of *S. murina* and *Antechinomys* frequently show indistinct facets formed

[1]This facet forms on the gently curved side of the protocone where at first it does not relate to the sharply curving surface of a crest, although with time and enough wear it usually comes to do so. Hence, for much of its existence, there is no distinct cutting edge involved with such a facet, and even though the thegosis type of microstriae do form as a result of tooth-to-tooth contact, the tooth sharpening aspects of true thegosis are missing until wear brings the facet and crest into proximity. To call attention to this distinction we refer to such facets as being "thegosed."

by food attrition, but they lack the "thegosed" microstriae that result from enamel contact.

The smallest Madura specimens have "thegosed" facets, but there is extensive overlap in size with those that lack them (figs. 9, 10, tables). This is similar to the relationship between the Recent specimens of *S. crassicaudata* and *S. murina*. On this basis, those specimens with a "thegosed" facet on the posterolingual surface of the protocone are assigned to *S. crassicaudata,* and those that lack it are tentatively assigned to *S. murina* with the realization that some *S. crassicaudata* may be included.

Sminthopsis Thomas, 1888

Sminthopsis crassicaudata (Gould, 1844)

This small phascogale, like the pygmy antechinus, is also a scarce element of the fauna. There are 12 specimens representing the lower jaws and mandibular dentition, and seven maxillaries and upper dentition as follows.

Material. –

MANDIBLES AND LOWER DENTITIONS

Trench 1, Unit 1, Top 1′

PM 25525, right ramus with P_2, P_4, M_1, M_4 and alveoli for other cheek teeth

WAM 72:3.8, right ramus with P_2-M_2 and alveoli for other cheek teeth (fig. 12)

PM 25528, right ramus with P_2, P_4, $M_{2\text{-}4}$ and alveoli for other cheek teeth

PM 25529, right ramus with P_2, M_1, and M_4 and alveoli for other cheek teeth

PM 25530, right ramus with $M_{3\text{-}4}$ and alveoli for other cheek teeth

PM 25534, left ramus with P_2-M_1, M_4 and alveoli for other cheek teeth

PM 25535, left ramus with C, P_2, P_4-M_4 and alveoli for other cheek teeth (fig. 13)

PM 25537, left ramus with P_2-M_4 and alveoli for other cheek teeth

Trench 2, Unit 2?

PM 25268, right ramus with M_3 and alveoli for other cheek teeth

Trench 3, Unit 2

TMM 41106-521, right ramus with P_3-M_2 and alveoli for other cheek teeth

WAM 72.3.9, right ramus with M_{2-4} and alveoli for other cheek teeth

Trench 4, Unit 1

TMM 41106-755, right M_3 (or M_2)

Maxillaries and Upper Dentitions

Trench 1, Unit 1, Top 1′

PM 25639, left maxillary fragment with M^{3-4}

Trench 3, Unit 2

PM 26139, right maxillary fragment with M^{3-4}

Trench 4, Unit 2, Level 1

PM 25744, right maxillary with M^{1-4} and all premolar alveoli (fig. 14A, B)

Trench 4, Unit 2, Level 2

WAM 72.3.10, right maxillary fragment with M^{2-3}, alveoli of other molars, and P^{3-4}

PM 25604, left maxillary fragment with P^4-M^3 and alveoli of canine and other premolars (fig. 14C, D)

Trench 4, Units 4-5

PM 25620, right maxillary fragment with M^{2-3}

Trench 4, Unit 7, Level 2

PM 25630, left maxillary fragment with M^2, alveoli for other molars, and P^4

Descriptions. — Lower molars of the animals assigned to this species are readily recognizable because of their distinctive, high, pillar-like entoconids, as can be seen in examples of Recent (fig. 11C, D) and fossil specimens (figs. 12A, B and 13A, B). Compare these also with *Sminthopsis murina* and *Antechinomys spenceri* (figs. 15C, D; 18C, D). This distinctive morphologic feature of the main lower molars (it is variable on M_4) may become quite reduced by wear. Even on a very worn tooth, wear facet evidence indicative

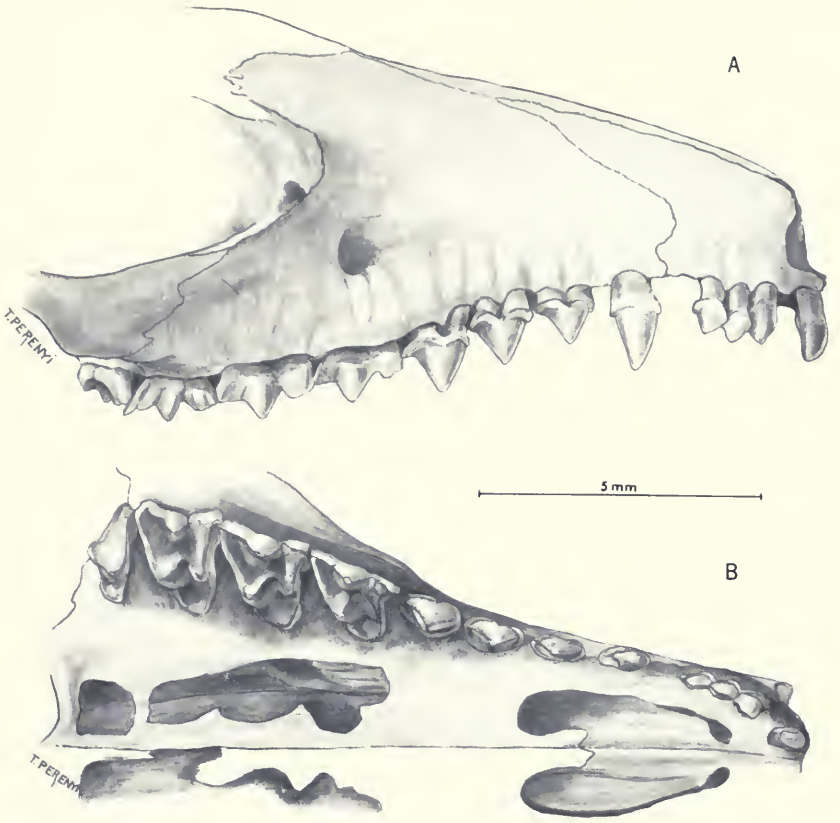


FIG. 11. Dentition of *Sminthopsis crassicaudata,* Recent specimen, FMNH 34723, shown enlarged approximately 8⅓ times. Right upper dentition in **(A)** lateral and **(B)** occlusal views.

of the original presence of this well-formed cusp is apparent. Hence, if a specimen preserves one of the lower molars with an entoconid of such relatively large proportions, it can be assigned to a member of *Sminthopsis* group A, and within that group size and proportions permit one to separate the smallest *S. crassicaudata* from some of its sister species (*S. rufigenis* and *S. larapinta*). From others, where proportions are nearly identical to those of *S. crassicaudata* (*S. macrura* and *S. stalkeri*), zoogeographic considerations are all we have, and they thus assume prime importance.

As noted earlier, the presence of a relatively wide masseteric fossa helps to distinguish *Sminthopsis* from *Antechinomys*, but it does not afford the means of separating the various *Sminthopsis*

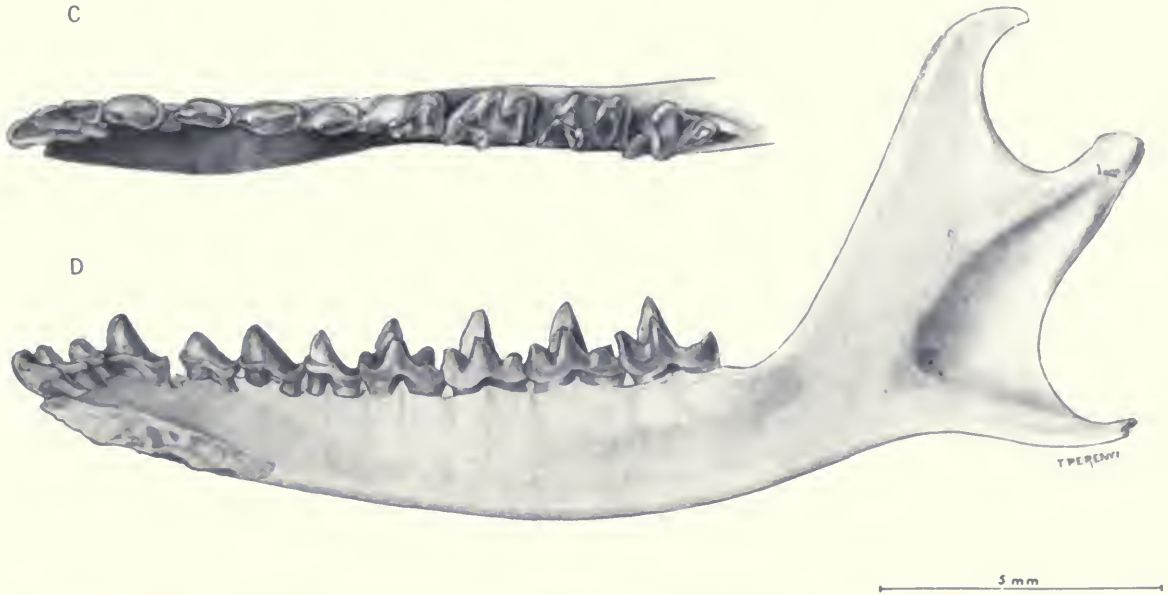


FIG. 11. Dentition of *Sminthopsis crassicaudata*, Recent specimen, FMNH 34723, shown enlarged approximately × 8½. Right lower dentition in **(C)** occlusal and **(D)** lingual views.

species from one another — or even the species group with certainty, although *Sminthopsis crassicaudata* does have a slightly higher condyle than *S. murina* in the few specimens available to us (fig. 1). Where lower molars are involved, *S. crassicaudata* is readily identified by the entoconids, in spite of the fact that dental dimensions and proportions are extremely close both to the other taxon of *Sminthopsis* in the fauna and to *Antechinomys*.

The mandible has the usual phascogaline form. There is an elongate, gently-tapered, and downwardly-arched horizontal ramus which bears three incisors, a short, somewhat premolariform canine, three small premolars (P_1 or P_2, P_3, and P_4) and four molars. There is a vertical, elongated ligamentary symphysis which runs from the tip of the jaw back to the level of the last premolar. The position of the mental foramen is variable on the lateral surface of the ramus. It lies beneath M_1 or even M_2, with subsidiary ones occasionally under the premolars. The ascending ramus has a broad, upward-flaring masseteric fossa and an upward- and backward-curving coronoid process that is somewhat hooked at its tip. It also has an articular process which, together with the posteroventral edge of the masseteric fossa, continues the arc of the curve of the ventral edge of the horizontal ramus in a bony strut that runs to and supports a flattened articular condyle. An inflected, delicate, attenuated, and arcuate angular process protrudes ventromedially from the arched lower edge of the jaw. The mandibular foramen opens posteriorly on the medial side just above the junction of the angle of the horizontal and ascending rami.

The Madura Cave material referred to *S. crassicaudata* resembles Recent specimens in the following ways: (*1*) the masseteric fossa is relatively broad, ranging from 24°-40°, usually about 30°-35°; (*2*) the condyle is in a relatively low position; (*3*) and as a result of *1* and *2*, the mandibular condyle is fairly evenly positioned between tips of angular and coronoid processes (fig. 1); (*4*) it has the distinctive high, columnar entoconids on M_{1-3} (often with a trace on M_4); and (*5*) details of dental proportions correspond as shown in the graphs (fig. 3A).

No specimen preserves any of the incisor teeth, nor are there any complete jaws, but WAM 72.3.8 and PM 25535 between them are representative (figs. 12, 13).

The lower canine is relatively low and elongated in crown view and its tip stands only slightly above the tips of the premolars;

hence it is somewhat premolariform. The three premolars are oval in occlusal outline. They are in line and are nearly the same size, the middle one, P_3, being slightly larger than the others. In each, the primary cusp is stout and high and is located over the anterior part of the tooth. Each is ridged anteroposteriorly, especially behind the main cusp. There is a developed posterior cingulum with a cuspule that is joined to the axial crest and a smaller anterior cingulum with a small central cuspule.

The lower molars have trigonids that are larger and stand higher than their talonids. The protoconid is the largest trigonid cusp in each, followed in order by metaconid and paraconid in M_{1-2}. In M_{3-4}, paraconid and metaconid are subequal. In M_{1-3}, the hypoconid is a stout, well-formed cusp about equal in bulk to paraconid and metaconid, but it arises from a lower base level. The distinctive pillar-like, attenuated entoconids already have been mentioned. Those of M_2 and M_3 are nearly as tall as the paraconid of the following tooth when unworn and are almost round in cross-section. That of M_1 is smaller, and the cusp is very small or absent in M_4. The entoconid and hypoconid, in most specimens with some wear, appear to be joined by a postcristid in M_{1-3}, and the hypoconulids are much lower but distinct and posteriorly projecting and joined to the posterior cingulum. In unworn teeth, the postcristid runs to the base or side of the entoconid where it turns sharply toward the hypoconulid. It may be weakly separated from the entoconid by a tiny elongate valley, which is readily obliterated by a slight amount of wear. In M_4 the talonid is nearly as long as the trigonid, but its cusp and crest development is variable. Each lower molar has a well-developed, steeply-inclined anterior cingulum. In M_{2-4}, between its highest point and the nearby parastylid, there is a notch that receives the preceding hypoconulid in an interlocking manner. In M_1 the cingulum runs to the paraconid, the parastylid being absent. Well-developed posterior cingula are present in M_{1-3}.

The most complete maxillaries in the collection (PM 25744 and PM 25604, fig. 14) between them preserve P^4-M^4. In PM 25604, the maxillary bone is nearly complete, lacking only bits from its posterior edge. Also, the area medial to the lacrymal and orbit and extending to the region of the junction of the frontal and nasal bone is missing. It appears that the snout was more vaulted and slightly larger than in our Recent materials, and it had a decidedly larger infraorbital foramen that opened above the anterior part of

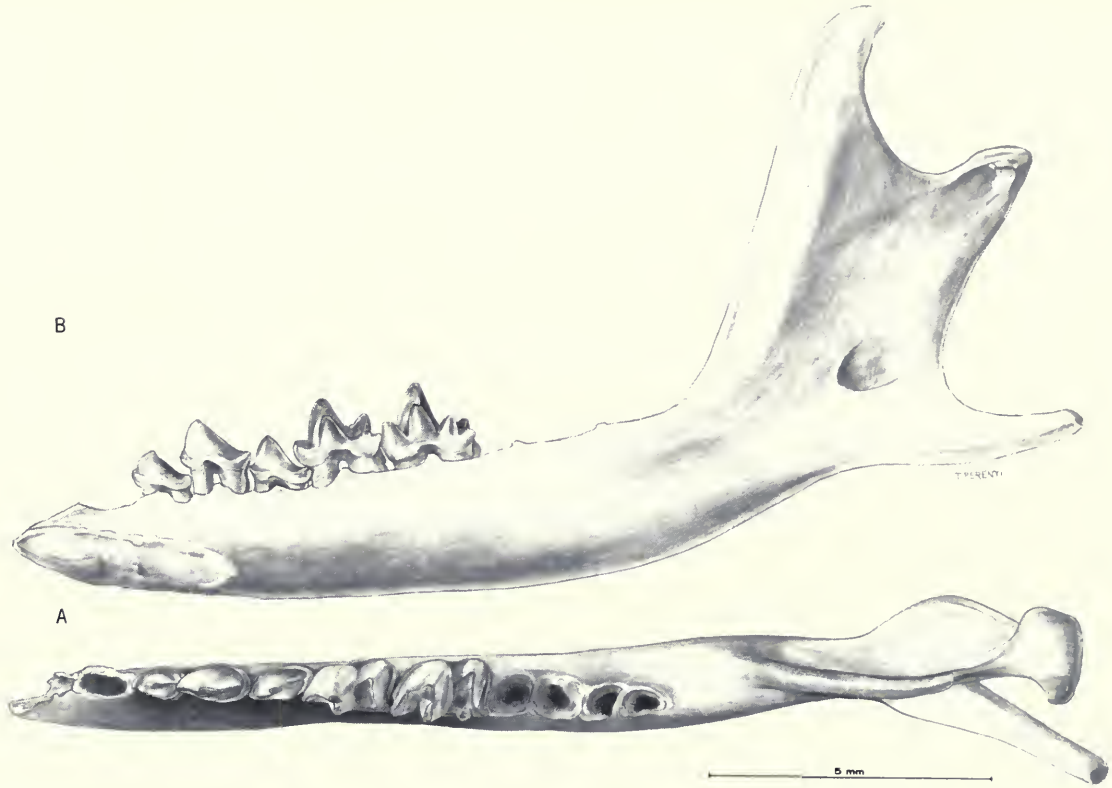


FIG. 12. *Sminthopsis crassicaudata* from Madura Cave, WAM 72.3.8, R. mandible with P_2-M_2 shown in crown **(A)** and lingual **(B)** views. Approximately × 8⅓.

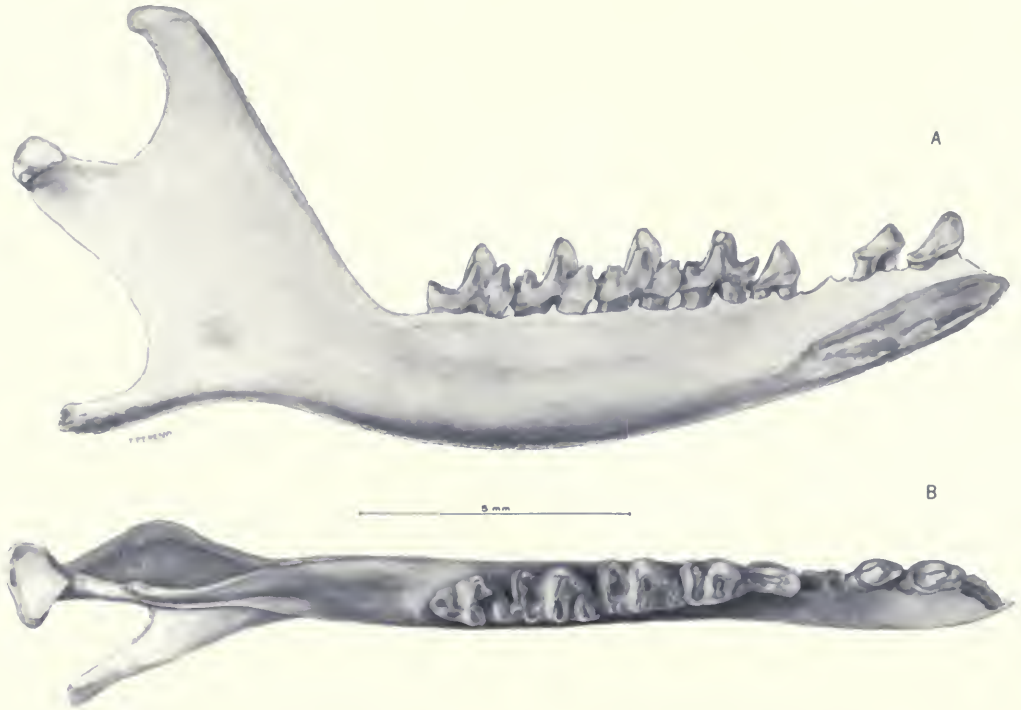


FIG. 13. *Sminthopsis crassicaudata* from Madura Cave, PM 25535, L. mandible with C, P_2, P_4-M_4 shown in lingual **(A)** and occlusal **(B)** views. Approximately × 8⅓.

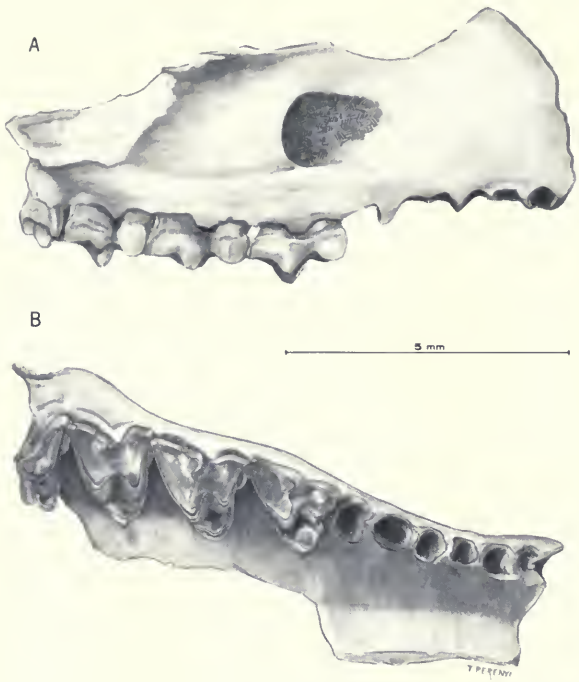


FIG. 14. *Sminthopsis* cf. *crassicaudata,* PM 25744, from Madura Cave. **A, B.** R. maxillary with M^{1-4} and alveoli of the premolars, shown in occlusal (A) and labial (buccal)(B) views.

M^1. In this last regard, it more closely resembles FM 60116, a captive specimen derived from South Australian stock. The premaxillary suture is a shallow, grooved structure with its medial flange protruding more anteriorly than the lateral one. The posterior limit of the left anterior palatal foramen is preserved; it lies close to the midline, directly opposite the center of the anterior premolar. The anterolateral edge of the main palatal vacuity lies near the medial root of M^1, slightly behind the position of its counterpart in TMM M-839 and more like that in FM 34723, modern specimens from Western Australia. The rest of the palate is missing behind this point except for the part directly supporting molars 1-3. The alveolus of the canine is oval with its longitudinal axis being about equal to the combined length of the next three alveoli (those for P^1 or P^2 and anterior root of P^3). All three premolars are double-rooted, the P^4 being the largest of them.

The P^4 has the usual form; it consists of a tall, single central cusp surrounded at its base by a cingulum that is continuous except

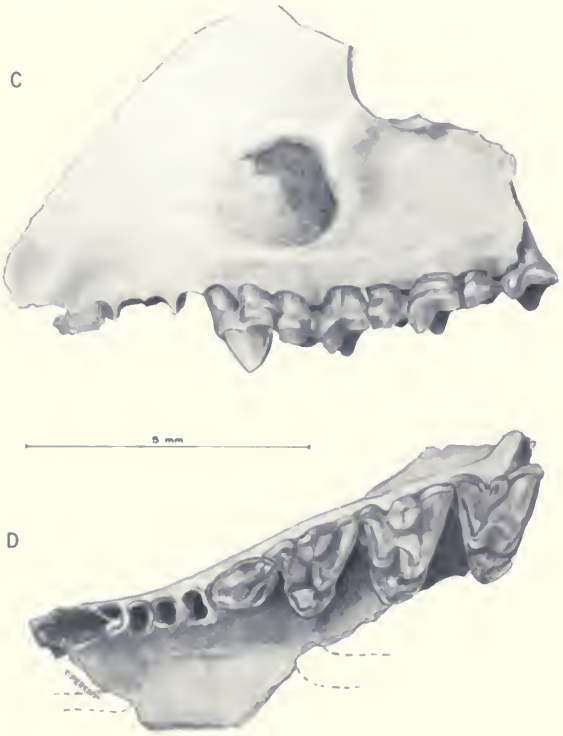


FIG. 14. *Sminthopsis* sp. from Madura Cave, PM 25604, left maxillary with P^4-M^3 and the alveoli of the other premolars and canine shown in **(C)** labial and **(D)** occlusal views. Both approximately × 8⅓.

for a gap near the back of the anterior root. It is more massive than in the Recent TMM M-839 and FM specimens from Western Australia, and it has a more triangular occlusal outline because of the expansion of the crown lingually beneath the posterior root. There is an axial crest that is weak and blunt anterior to the cusp and which bears a heavy-wear facet behind the cusp from its tip to base and out onto the posterior cingular cusplet.

The molars are very much like those of the Recent FM and TMM specimens in most details, the few differences being a slightly more massive build to each tooth. These subtle differences can be seen most readily by comparison of the "lengths" of the M^1's, measured from the anterior edge of the parastyle to the back side of the tooth at the metacone, and by comparison of the lengths and areas of the stylar shelves in the M^3's. All three are basically

triangular in crown view outline, and the anterior and buccal edges of each are nearly at right angles to one another. The protocones are low and ridged from the tip. The anterior ridge runs buccad to a low protoconule in M^1 and to the protoconular region in the others where the conule is weak or absent. In M^1 this crest then continues onward weakly along the anterior base of the paracone, then abruptly expands to become stout as it joins the longitudinally-ridged parastyle. In M^{2-3} this ridge is interrupted along the base of the paracone; the break is short on M^2, larger on M^3. The posterior crest of the protocone runs back to a weak but definite metaconule in each tooth, then rapidly fades away at the posterolingual side of the base of the metacone. In descending order of height, the primary cusps are metacone > paracone > protocone, and while the protocone has a more massive appearance in crown view, it is about equal in bulk to the taller metacone. The paracone is much the smallest of the three cusps. The stylar shelf is expanded buccad in each tooth, except for the anterior (paracone) region in M^1, and the eocrista is strongly W-shaped. The ectoloph has a weak stylocone that is connected by one ridge to the paracone and by another to the parastyle. There is a notch in the buccal border of the ectoloph, and a valley runs from this to the central flexure of the W of the eocrista. This notch is deep and is bordered anteriorly and posteriorly by strongly curved shoulders. The anterior shoulder is made up of the stylocone and the posterior one by a large stylar cusp (cusp C or D of Bensley, 1903) that sits immediately behind the notch. This cusp is largest in M^1, smallest in M^3, and in all three is ridged so that weak crests run from the tip. One of these crests goes back along the buccal edge of the tooth to the metastyle, the other runs a short distance lingually toward the base of the cusp. The metastyle is drawn out posteriorly and buccally, especially on M^{1-2}. Wear is greater on PM 25744 than on PM 25604, but it preserves M^4 (as does PM 25639), which consists of a prominent eocrista that runs from a fused parastyle-stylocone to a stout paracone and on to a reduced but distinct metacone. Lingual to the metacone, and reduced almost to a cingular vestige is a small, ridged protocone. Like the other molars, the M^4 is three-rooted, but the posterior of the buccal pair of roots is extremely reduced, and it is shifted lingually to lie close against the lingual root.

Discussion. — Several characters of the Madura specimens, such as the large infraorbital foramen and the deep notch between

the stylocone and cusp D, are more similar to those of Recent specimens from South Australia than to material from Western Australia. However, the Recent samples available to us are too small to permit one to draw conclusions from this.

This species is widely distributed in Australia today but is not known to occur on the Nullarbor Plain, although Lundelius (1957, 1963) recorded it in surficial deposits from various caves in this region. Its presence in every stratigraphic level in Madura Cave indicates that it has been an element of the fauna of this region through the late Pleistocene, as well as part of the Holocene.

Sminthopsis murina (Waterhouse, 1838)

This taxon, like *S. crassicaudata* and the indeterminate pygmy antechinus described earlier, is scarce in the Madura fauna.

Materials. –

MANDIBLES AND LOWER DENTITIONS

Trench 1, Top 1′

PM 25532, left mandible with P_2-M_4 (fig. 16C, D)

Trench 2, Top 1′

PM 25269, left ramus fragment with M_4

Trench 3, Unit 2

WAM 72.3.11, right ramus fragment with P_{2-4}, M_{3-4} (fig. 16A, B)

PM 25757, right ramus fragment with M_{3-4}

WAM 72.3.12, left ramus with P_4-M_2

PM 25791, right ramus with P_4-M_3

PM 25793, right ramus with P_3, M_{2-4}

Trench 4, Unit 1, Level 1

TMM 41106-479, right ramus with P_4-M_1 and alveoli of all other teeth

PM 25636, left ramus fragment with M_4?

Trench 4, Unit 1, Top 1′

PM 26306, ramus juvenile with P_4

Trench 4, Unit 2, Level 1

PM 25715, right mandible with M_4

PM 25737, left ramus with M_{3-4}

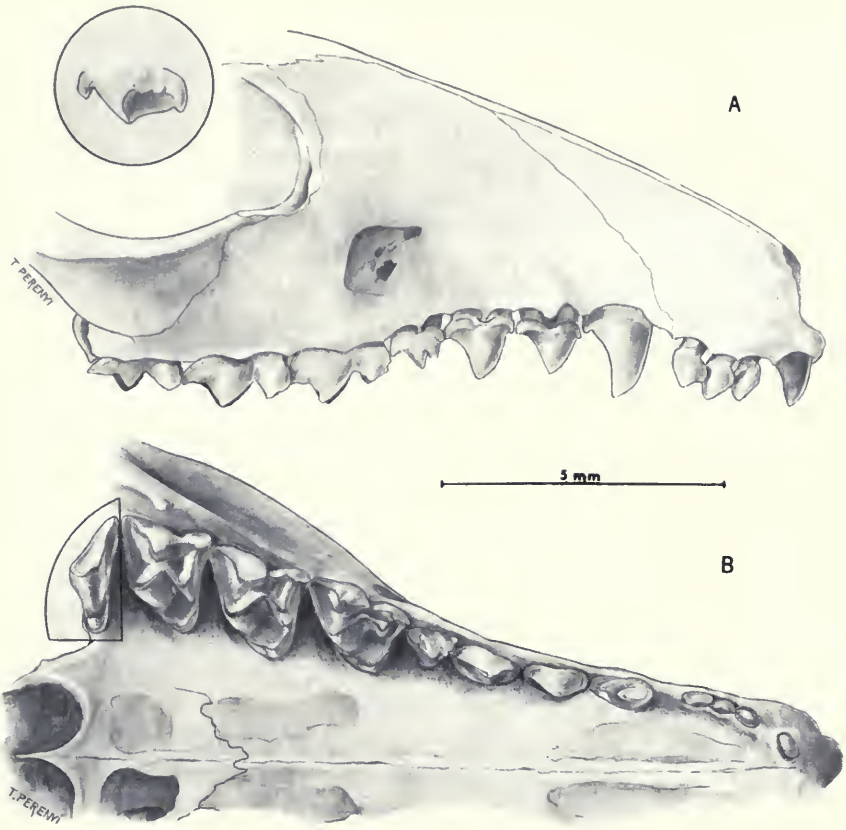


FIG. 15. Dentition of *Sminthopsis murina,* Recent juvenile specimen with the deciduous premolars functional, TMM M-840. The dP^4 is somewhat molariform, the P^4 and $dP_4$are not.

R. upper dentition is shown in lateral **(A)** and occlusal **(B)** views. The R. mandible with its full dentition is shown in lingual view **(D),** and the lower teeth are shown in occlusal view **(C).** In A, M^4 is shown partially erupted, as it is in the specimen, while in B it is shown as fully erupted so as to expose its crown surface to view. Approximately × 8⅓.

Trench 4, Unit 2, Level 2

PM 25600, left ramus fragment with M_4

PM 25606, left ramus with P_3

PM 25711, right ramus fragment with M_4

WAM 72.3.13, left ramus fragment with M_4

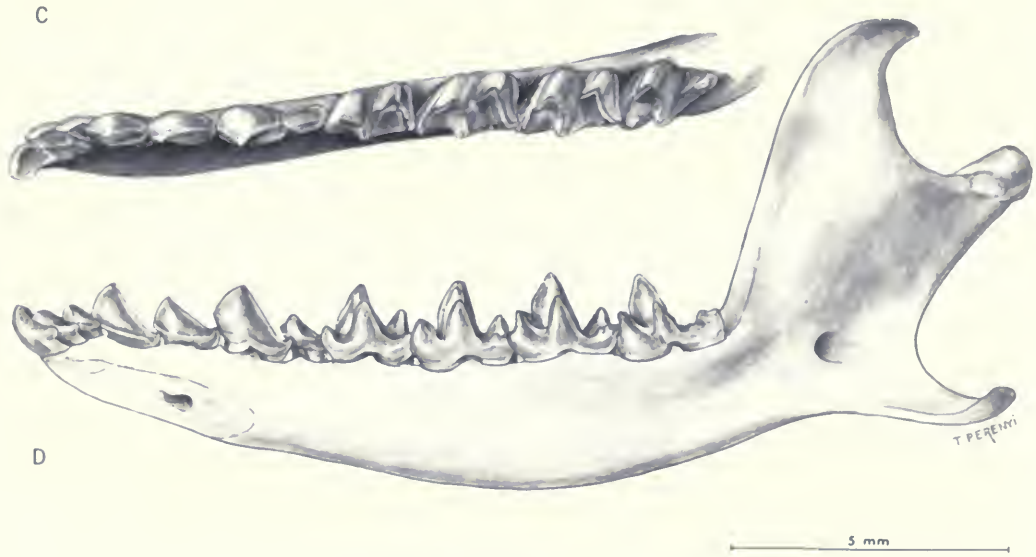


FIG. 15, C, D.

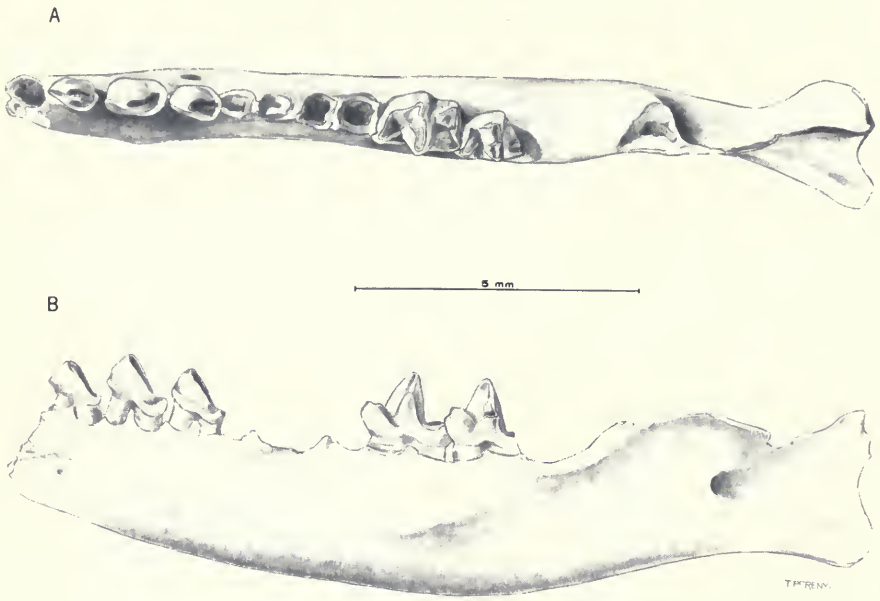


FIG. 16. *Sminthopsis murina* from Madura Cave. **A, B.** WAM 72.3.11, R. ramus with P_{2-4}, M_{3-4} and alveoli of C and M_{1-2}, in occlusal (A) and lingual (B) views.

Trench 4, Unit 2, Level 3

PM 25635, left ramus with M_4

Trench 4, Unit 7, Level 2

PM 25629, left ramus with M_{3-4}

MAXILLARIES AND UPPER DENTITIONS

Trench 1, Top 1′

PM 25531, left maxillary with P^1 or P^2- M^3, alveoli for M^4, and canine (fig. 17C, D)

Trench 3, Unit 2

WAM 72.3.14, right maxillary with M^{2-3} and part of M^4

PM 25797, left maxillary with M^{1-4} and alveoli of canine and premolars

PM 26140, right maxillary with M^{1-3}

PM 26148, right maxillary with M^{1-2}

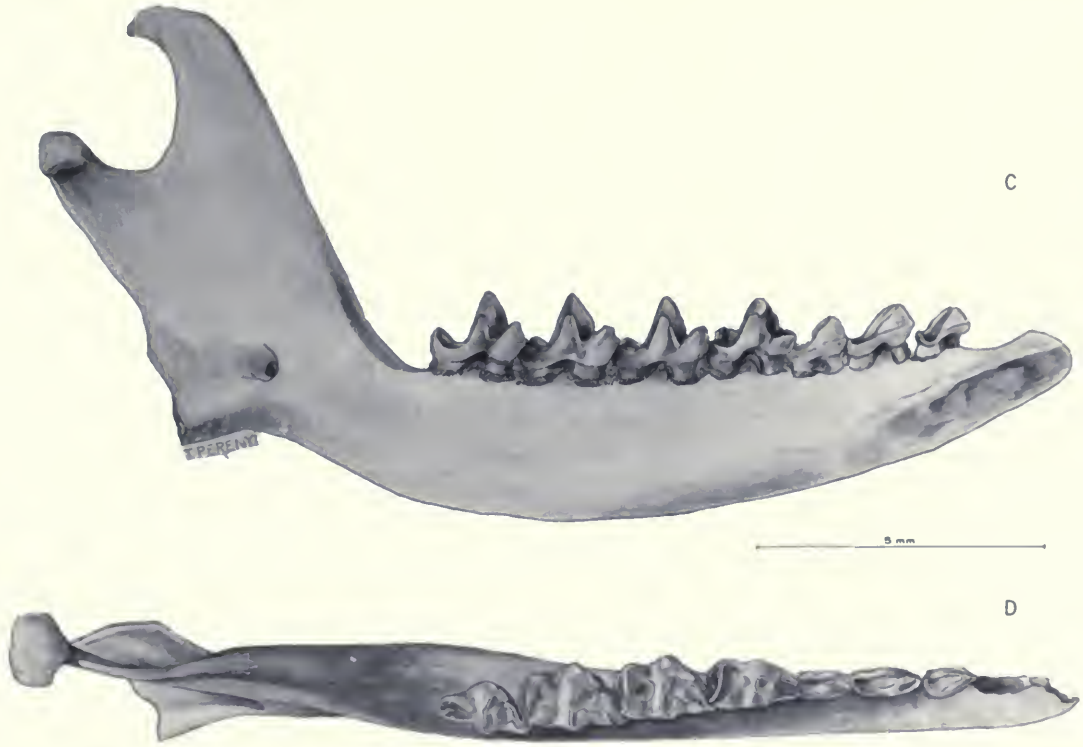


FIG. 16. **C, D.** *Sminthopsis murina* from Madura Cave. PM 25532, left ramus with P_2-M_4 and alveoli for the other teeth, shown in **(C)** lingual and **(D)** occlusal views. All approximately × 8⅓.

Trench 4, Unit 1, Level 1

TMM 41106-480, right maxillary with M^{1-2}

WAM 72.3.15, left M^1

Trench 4, Unit 2, Level 1

PM 25745, right maxillary with M^{2-4} (fig. 17E, F)

Trench 4, Units 4-5

TMM 41106-761, left M^2

Descriptions. — The horizontal ramus of the mandible is slender and tapers anteriorly. The ventral margin is gently convex from the base of the angular process to the anterior end and does not show any tendency for the anterior portion to be flattened, as in *Antechinomys*.

A variable number (up to three) of mental foramina are present. They are located under the premolars and M_1, with that beneath M_1 usually being the largest and most consistent.

The symphysial joint is ligamental. It extends from the anterior end of the horizontal ramus to a position under the anterior end of the P_4.

The posterior part of the mandible has the characteristic structure of *Sminthopsis*. The anterior margin of the ascending ramus rises steeply, the masseteric fossa is broad, and the condyle is located relatively low with respect to the tooth row.

The articular surface of the condyle is slightly rounded anteroposteriorly but not laterally. This is in contrast to the flat condition in *Antechinomys*. It also differs from that of *Antechinomys* in its more oval shape.

The angular process is inflected at about 45° to the vertical plane of the ramus. None of the Madura Cave species preserves a complete angular process, so its size cannot be determined.

No incisors or canines are preserved in the mandibles. The alveoli of the incisors and the canine indicate that these teeth were procumbent as in Recent specimens. The alveoli of the incisors are elliptical in cross-section and show the same kind of crowding seen in the Recent specimens. The alveolus of the canine is usually elongate or elliptical, but the lateral wall may be reduced so that it may be triangular.

The lower premolars are all double-rooted and have a single major cusp located over the anterior root. The P_3 is the largest, and the P_2 is the smallest of the premolars. They are roughly elliptical in cross-section. The overlap of P_4 and M_1 is variable but never great. The cusps of each are crested anteroposteriorly, especially posteriorly. The posterior crest descends rapidly and joins a posterior cingular cuspule at the posterior edge of the tooth. This crest is clearly an important functional part of the tooth as it shows a considerable amount of wear in all the specimens we have. The posterior cingulum and its posterior cuspule form a talonid-like structure at the back of the tooth.

The molars show the usual tribosphenic form seen in the Phascogalinae (figs. 15C-D, 16). In crown view, M_{1-2} are always tapered; narrower anteriorly. In M_3 the two moieties are about equal, and in M_4 the taper is sharp posteriorly.

The molars all have high trigonids that are dominated by the protoconid. The paraconid is weakest and lowest on M_1. In all molars except M_4 the metaconid is the second largest trigonid cusp, and the paraconids show a progressive increase in size from M_1 to M_4 so that in M_4 the paraconid and the metaconid are subequal. Crests connect the protoconid to the paraconid [paracristid (I′)] and to the metaconid [epi-centrocristid (II′ and I‴)] across V-shaped valleys that initially have a weak cleft (carnassial notch) and groove at the bottom. Wear may quickly erase this feature, but it usually persists longer on the paracristid than in the epi-centrocristid except in M_1, in which the paracristid is poorly developed.

Viewed from above, the epi-centrocristids are oriented 5° off from the transverse axis of the teeth (and jaw ramus) in M_{2-4}, with the metaconids slightly posterior to the protoconid. The angle formed by the paraconid, protoconid, and metaconid is about 40°. This is different from *Antechinomys* in which the same angle in M_{2-3} is slightly smaller (M_2, 35-40°; M_3, 30-35°). This is reflected in the differences between those two taxa in the scatter diagrams of trigonid length versus trigonid width (anterior width) in which the trigonids of *Sminthopsis murina* are narrower relative to their length than in *Antechinomys* (fig. 7). This is particularly true of M_3 in which there is virtually no overlap in the clouds of points of the two taxa (fig. 6).

The scatter diagrams (figs. 6, 7) and Tables 6, 10, 12, 13 show that the sample of fossil *S. murina* is on the average slightly smaller

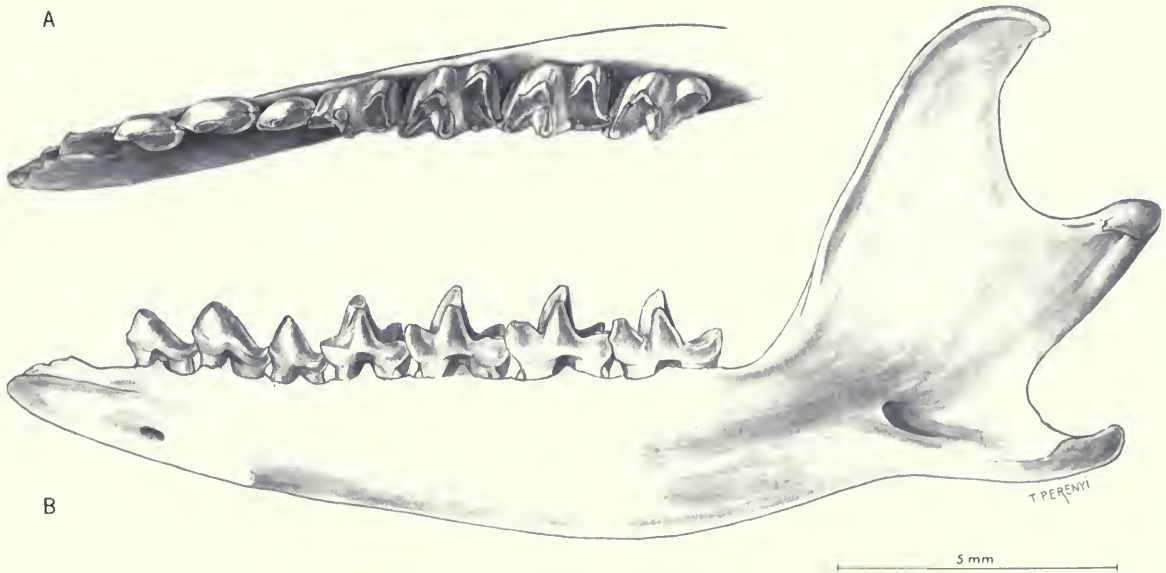


FIG. 17. **A, B.** *Sminthopsis* cf. *murina,* one of the *S. "hirtipes"* specimens from the large Hastings Cave, W. A. sample which on the basis of dental measures is now believed to be referrable to *S. murina.* PM 16581, R. mandible with P_2-M_4, is shown in (A) occlusal and (B) lingual views. Approximately × 8⅓.

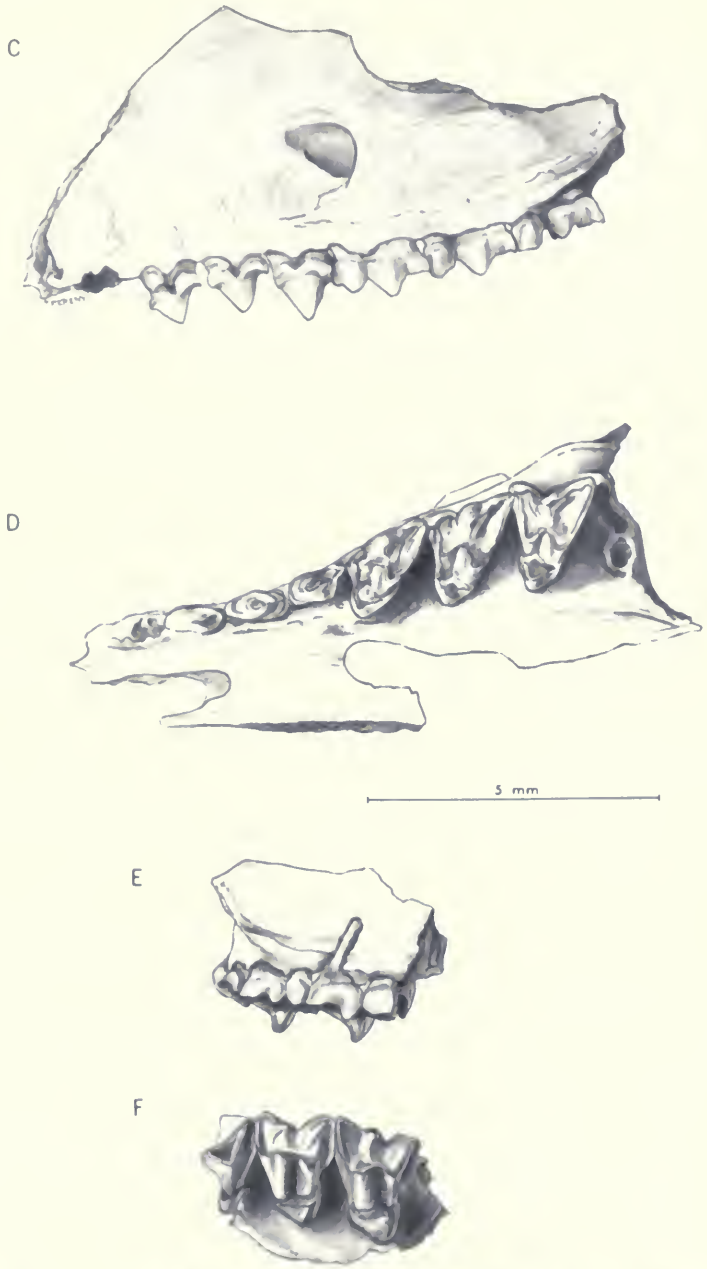


FIG. 17. **C, D, E, F.** *Sminthopsis murina* from Madura Cave PM 25531, L. maxillary with all three premolars, M^{1-3}, and the alveoli for C and M^4, shown in labial and (D) occlusal views. PM 25745, R. maxillary fragment with M^{2-4} shown in (E) labial and (F) occlusal views. All approximately × 8½.

in most dental dimensions than fossil *Antechinomys*. The exceptions are the trigonid lengths of M_{2-3} in which the means of the *S. murina* sample are slightly larger than those of *Antechinomys*.

The M_1 is much more tapered anteriorly than the other molars with the metaconid close against the protoconid. The short epicentrocristid is oriented at an angle of 70° to the long axis of the tooth row. The antero-external cingulum is variable in size, ranging from a large feature that gives an angled appearance to the antero-external corner of the tooth to virtual absence.

In unworn teeth a valley runs diagonally across the floor of the trigonid from the bottom of the V in the paracristid to the gap between paraconid and metaconid. With progressive wear the center of the trigonid becomes smoothly basined. Each trigonid is situated over the anterior root.

The talonids are broad, basined, lower than the trigonids, and are located over the posterior root of the tooth. They are dominated by the hypoconids which are so formed that their anteromedially- and posteromedially- directed crests form V's in an *en echelon* arrangement behind and below those of the protoconids.

Entoconids are variably developed; small to absent. When present they lie at the extreme medial edge of the tooth and are usually elongated antero-posteriorly. They may be connected by a weak crest to the metaconid and also to the hypoconulid.

The hypoconulids are distinct and well formed. They project backward so as to interlock between the parastylid and the medial end of the anterior cingulum of the next tooth. In old individuals with extremely worn teeth, they become reduced. The posterior crest from the hypoconid extends nearly to the medial edge of the tooth before turning sharply posteriorly to join the hypoconulid. At the point of inflection, it joins a variably-developed, short, diagonal crest which trends inward toward the center of the talonid basin. With wear that portion of the talonid basin behind this ridge loses its enamel over a triangular-shaped area and the ridge becomes accentuated.

Stout anterior and posterior cingula commence low on the labial side of the front and back edges of each molar tooth (except the rear of M_4). They rise as they cross the tooth toward the medial corners.

The talonid of M_4 is narrow and elongate, even more so than *Antechinomys*, with a single, dominant posterior cusp, the hypoconid. In many specimens it is connected to the base of the metaconid (and epicristid) by a low cristid obliqua (I'''b) that extends from its apex obliquely forward across the talonid.

The maxillary and upper molars of *Sminthopsis murina* (figs. 15A-B, 17C-F) are so similar to those of *S. crassicaudata* that they are separable only with extreme difficulty and some uncertainty. Separations are based largely on dental measurements and the absence of "thegosed" wear facets on the posteromedial sides of the protocones.

The following description is based on PM 25797 except as otherwise noted. A small part of the premaxillary suture is preserved, but there is no sign of a flange to the suture.

The infraorbital foramen is preserved in PM 26140 and PM 26148, as well as PM 25797. It is variable in size, being appreciably larger in PM 26148 than in the other two specimens. It is located over the anterior half of M^1 and occupies the middle third of the space between the alveolar margin and the suture with the lacrimal.

The posterior margin of the anterior palatal foramen is opposite the posterior root of the anterior-most premolar. The anterior margin of the posterior palatal vacuity is opposite the center of P^4, and its lateral limits can be discerned posteriorly to opposite the posterior half of M^2 behind which the definitive edge is broken away.

The alveoli of the premolars indicate that these teeth were shorter than any of the molars except M^4.

The molars of PM 25797 show little wear and are proportioned like those of TMM M-840. The morphology of the upper molars is very much like those of *S. crassicaudata*. In one detail the Madura Cave specimens seem to differ from the Recent *S. murina*. The posterior crest of the protocone is sharper and more pronounced in the fossil specimens. The stylar shelves are slightly more expanded buccally than in the modern specimen, which gives the teeth a more laterally stretched-out appearance.

In the little-worn specimen, PM 25797, M^2 and M^3 have a weak but definite stylar cusp between the large central stylar cusp and the metastyle. A faint trace of this can be seen in TMM M-840 and in one of the two specimens (MVZ 133183) from eastern Australia. This cusp is generally absent from *S. crassicaudata* but is

sometimes present, though weakly developed. In the M^4 the basin of the stylar shelf is larger; the tooth is slightly larger than in *S. crassicaudata.*

Specimen PM 25531, one of the most complete of the *Sminthopsis* specimens, is, unfortunately, not unequivocally referrable to species on the basis of the criteria used here. It has extensive (but non-striated) facets on the posterolingual faces of the protocones, features which do not support one assignment over the other. The parastyle to paracone distance suggests *S. crassicaudata* affinities. However, the overall size appears to ally it with *S. murina,* as does the broader stylar shelf and the generally broadened aspect of the molars. Overall, its affinities appear to be closest to *S. murina,* and we tentatively assign it to that species.

It is the only specimen with a complete premolar series preserved. The premolars increase in size from front to back. They are double-rooted teeth, and each has a single main cusp centered over the area between the anterior and posterior roots. The cusp is rounded anteriorly and crested and somewhat worn posteriorly. Anterior and posterior cingula are present, the latter being prominent.

The palate is nearly complete. The anterior palatal foramen extends posteriorly to a point opposite the region between the first two premolars. The large posterior palatal vacuity does not extend as far forward as in PM 25797, but it appears to go only to a point opposite the region between P^4 and M^1. In the Recent specimens available these vacuities reach only to the level of the medial root of M^1.

Discussion. — The distribution map in Marlow (1962) shows that the species occurs in the wetter coastal areas in both Western Australia and the eastern part of the continent. It has been reported from the Nullarbor from Doldea (Troughton, 1964) and from cave N-59 (Archer, 1972).

Remains of *S. murina* occur in units 1, 2, and 7 of the Madura Cave sequence. Like *S. crassicaudata,* it was part of the fauna of the Nullarbor Plain during the late Pleistocene and early Holocene. Its absence in unit 4-5 is probably an accident of sampling.

Antechinomys Krefft, 1867

Antechinomys spenceri Thomas, 1906

This is the most abundantly represented species of phascogale in the Madura fauna. There are 127 specimens in all, not counting many isolated teeth.

Materials: — Specimens with an asterisk (*) are those which could not be identified by the masseteric fossa criterion but which plotted within the range of points for positively-known *A. spenceri* (narrow fossa) and are therefore included tentatively.

Mandibles and Lower Dentitions

Trench 1, Top 1′

PM 25527, complete right ramus with M_{2-4} and alveoli of other teeth

PM 25533, left ramus with P_2, P_4-M_4, and alveoli of other teeth; lacks only condyle and end of angular process

PM 25536, nearly complete left ramus with P_2-M_2 and alveoli of other teeth; lacks only end of angular process

Trench 1, Unit 1, Top 30″

PM 26166, right ramus with P_2 and alveoli of all cheek teeth; lacks condyle, tip of coronoid process, and much of angular process

Trench 3, Unit 2

TMM 41106-120, right ramus with P_4-M_1

TMM 41106-121, right ramus with P_2 and alveoli of rest of teeth

WAM 72.3.16, left ramus with P_{2-3} and M_{2-4}

TMM 41106-123, left ramus with P_2-M_4

TMM 41106-124, left ramus with M_{3-4}

TMM 41106-125, right ramus with M_{2-4}

TMM 41106-126, right ramus with P_3-M_4

TMM 41106-128, left ramus with P_4-M_4

TMM 41106-129, right ramus with P_2, P_4, and M_{2-4}

TMM 41106-130, left ramus with P_2 and M_1

TMM 41106-131, left ramus with P_{2-3}

PM 25750, right mandible edentulous

PM 25754, left ramus with P_4-M_4

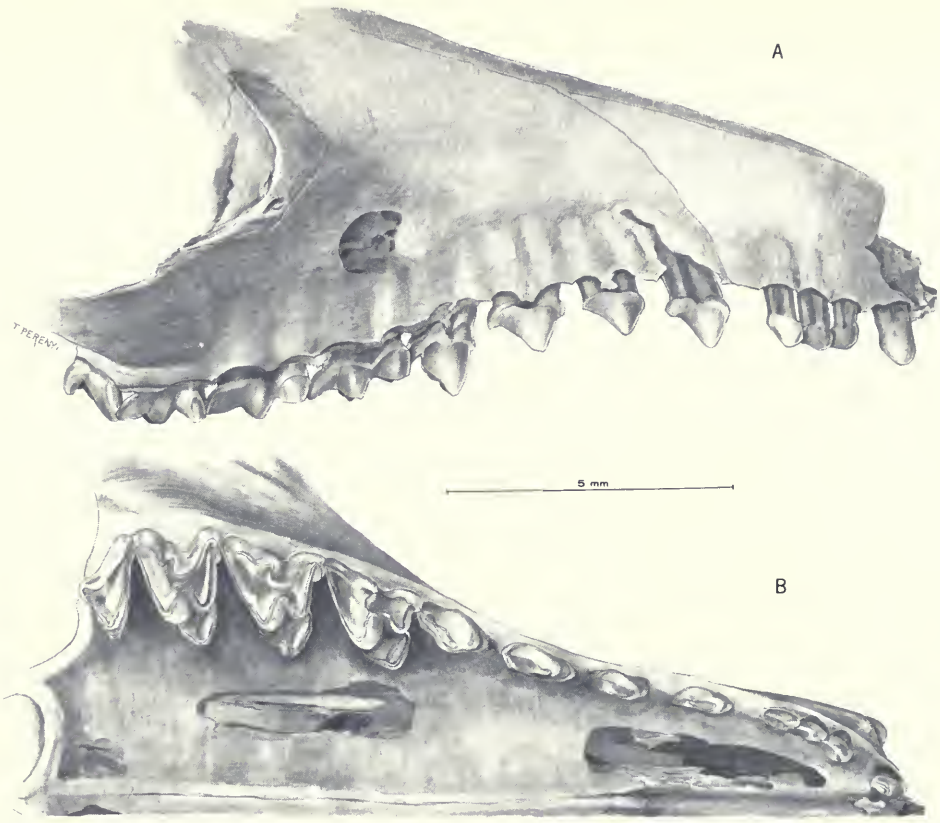


FIG. 18. Dentition of *Antechinomys spenceri,* Recent specimen, AMNH 15012, shown enlarged approximately × 8⅓. Right upper dentition shown in lateral **(A)** and occlusal **(B)** views.

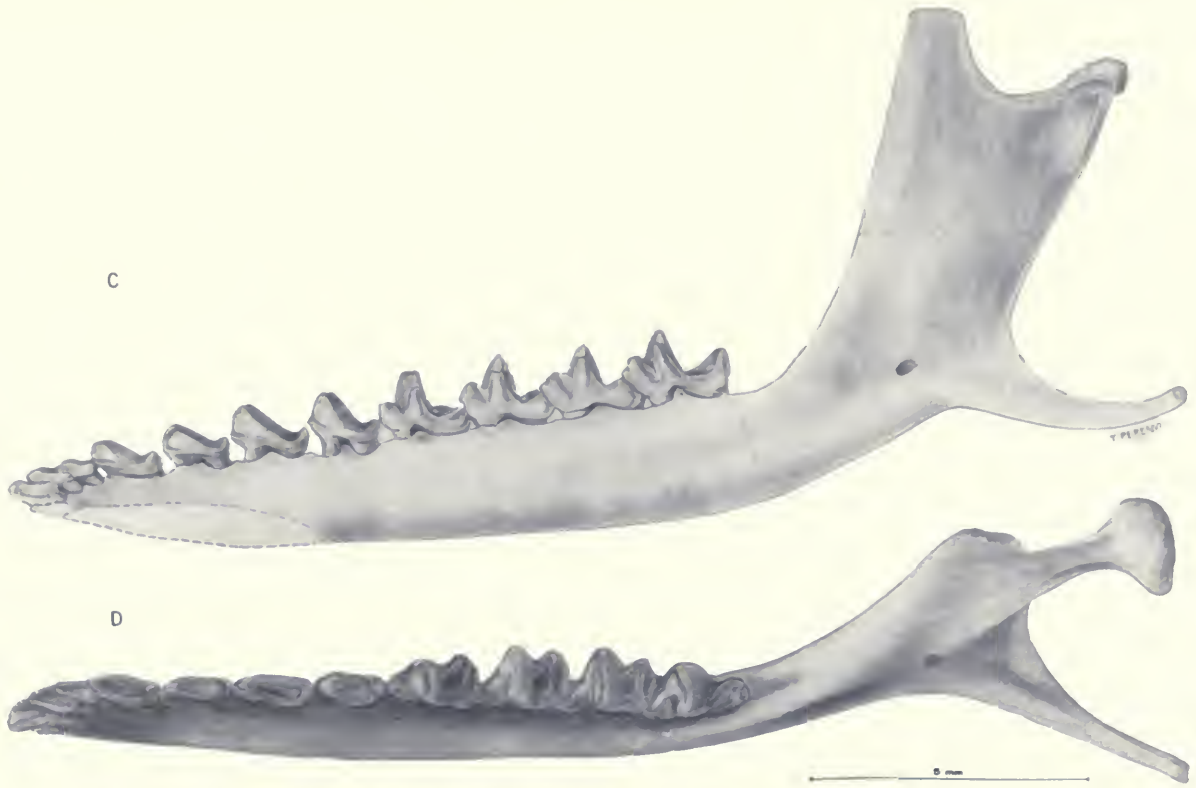


FIG. 18. Dentition of *Antechinomys spenceri*, Recent specimen, AMNH 15012, shown enlarged approximately × 8½. **C**, right lower dentition shown in lingual view; **D**, in occlusal view.

PM 25755, right ramus with M_{2-4}
PM 25756, right ramus with M_{2-3}
PM 25759, right ramus with M_{3-4}
PM 25760, left ramus with P_{2-3}
PM 25761, right ramus with M_4
PM 25762, right ramus with P_2-M_4
PM 25763, left ramus with P_{2-3} and M_{1-4}
PM 25764, left ramus with M_{1-2}
PM 25765, left ramus with M_{3-4}
PM 25766, right ramus with M_{2-4}
PM 25767, right ramus with P_2 and M_{1-2}
PM 25768, right ramus with M_{3-4}
PM 25769, right ramus with M_{1-4}
PM 25770, right ramus with P_{3-4}
PM 25772, left ramus with M_{3-4}
PM 25774, left ramus, edentulous
PM 25775, left ramus with P_2 and P_4-M_4
PM 25776, left ramus with M_{1-4}
PM 25777, left ramus with M_{1-4}
PM 25778, left ramus with M_{2-4}
PM 25779, left ramus with P_2 and M_1
PM 25780, left ramus with P_{3-4}
PM 25781, left ramus with M_3 and angle
WAM 72.3.17, left ramus edentulous, with angle
PM 25785, left ramus with P_2-M_1
PM 25786, left ramus with M_{2-4}
PM 25788, right ramus, edentulous
PM 25790, right ramus with M_3 and angle
WAM 72.3.18, right ramus with P_4-M_1

Trench 3, Unit 2, Level 2
PM 26161, left ramus with M_4

Trench 3, Unit 2, Level 4

WAM 72.3.19, left ramus with M_{1-2}

PM 26153, right ramus with M_{2-3}

PM 26156, left ramus with M_{2-3}

PM 26157, right ramus with M_{2-4}

PM 26158, right ramus with M_{2-4}

PM 26159, right ramus with P_3-M_3

PM 26160, right ramus with M_{1-4}

Trench 4, Unit 1

TMM 41106-520, left ramus with P_{3-4} and alveoli of rest of teeth (fig. 19A, B)

Trench 4, Unit 2, Level 1

TMM 41106-325, left ramus with P_4-M_4

PM 25716*, right ramus with P_2 and M_{1-4}

PM 25717, right ramus with P_4-M_4

PM 25718, left ramus with P_2 and P_4-M_4

PM 25719, left ramus with P_2 and M_{1-4}

WAM 72.3.20, left ramus with P_2-M_1 and M_{3-4}

WAM 74.9.1, right ramus edentulous

PM 25723, right ramus edentulous

PM 25724, right ramus edentulous

PM 25725, right ramus edentulous

PM 25726, right ramus edentulous

PM 25727, left ramus with M_3 and angle

PM 25728*, left ramus fragment with M_1

PM 25729*, left ramus with P_{2-3}

PM 25730*, right ramus fragment with M_1

PM 25732*, left ramus with M_1

PM 25733*, left ramus with P_4

PM 25734, right ramus with P_4-M_4

PM 25735, right ramus with P_2-M_4

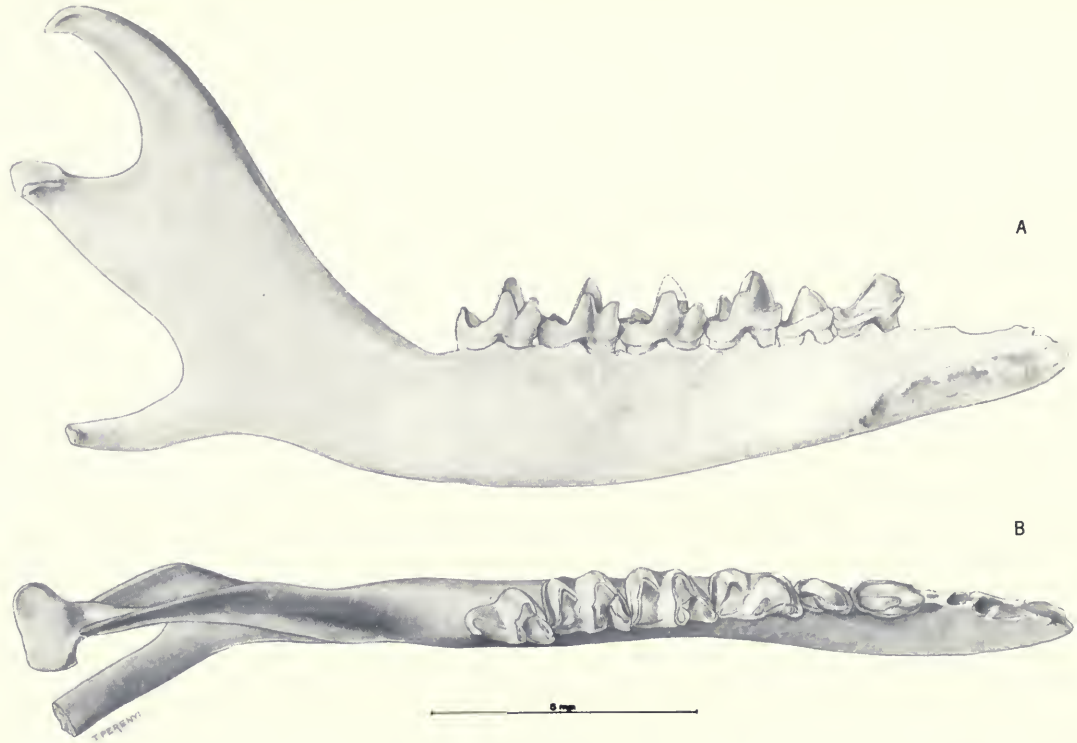


FIG. 19. *Antechinomys spenceri* from Madura Cave, TMM 41106-520, L. mandible with P_3-M_4 shown in lingual **(A)** and occlusal **(B)** views. Approximately × 8⅓.

WAM 74.9.2, right ramus with M_{1-2}

PM 25747, right ramus with M_3

PM 26305*, left ramus with M_{1-3}

Trench 4, Unit 2, Level 2

PM 25598, right ramus with M_{1-4}

PM 25599*, left ramus with M_{3-4}

PM 25603*, left ramus fragment with M_1

PM 25605, left ramus with P_4-M_1 and M_4

Trench 4, Unit 7, Level 2

PM 25628*, right ramus with M_3

Maxillaries and Upper Dentitions

Trench 3, Unit 2

WAM 74.9.3, left maxillary with M^{1-3}

PM 25749, right maxillary with M^{1-4}

PM 25758, right maxillary with P^{3-4}

PM 25771, left maxillary with M^{1-4}

PM 25773, right maxillary with M^1

PM 25796, right maxillary with M^{2-3}

PM 25798, right maxillary with P^4-M^4 (fig. 21A, B)

PM 25799, left maxillary with P^3, M^{1-4} (fig. 20A, B)

PM 26141, left maxillary with M^{1-4}

PM 26142, right maxillary with M^{1-3}

PM 26143, right maxillary with M^{2-4}

PM 26144, right maxillary with M^3

PM 26145, right maxillary with M^{2-4}

WAM 74.9.4, right maxillary with P^{3-4}

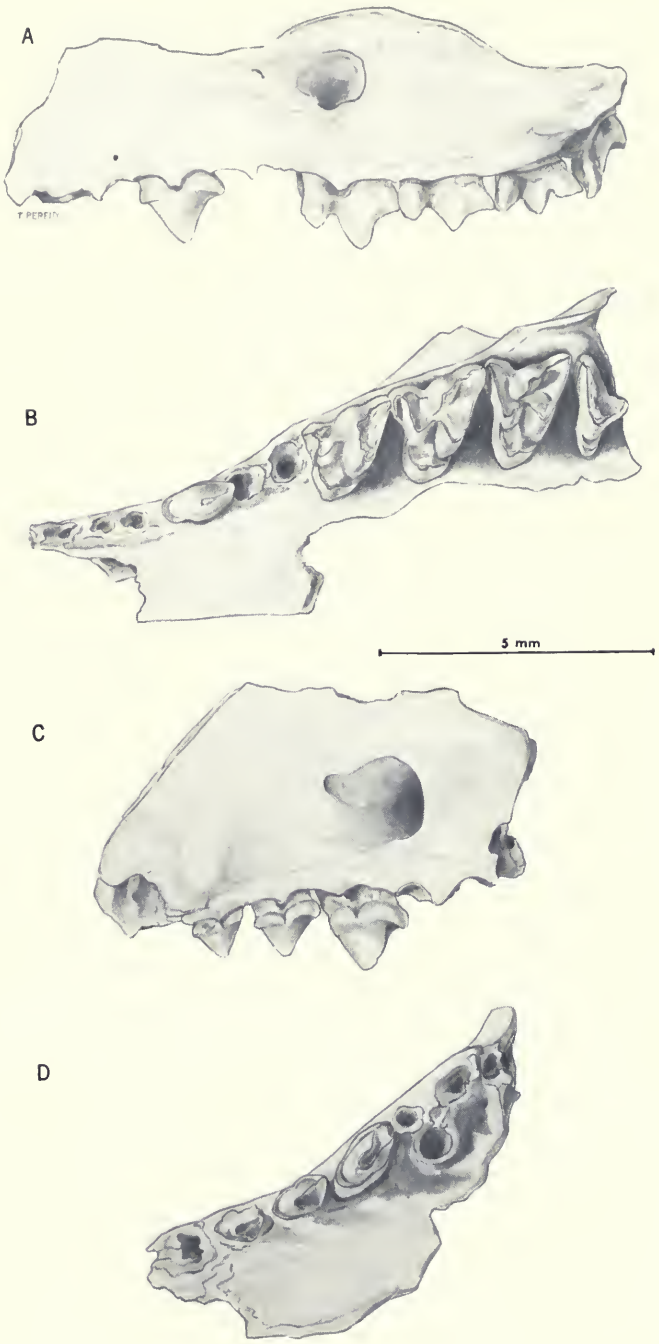
PM 26147, left maxillary with M^{2-4}

PM 26149, right maxillary with M^{2-3}

PM 26150, left maxillary with M^{2-4}

PM 26151, left maxillary with M^1

PM 26154, left maxillary with M^1


A
B
5 mm
C
D

PM 26162, left maxillary with M^3

PM 29910, left maxillary with broken M^3 and alveoli of M^2 and M^4

TMM 41106-139, right maxillary with M^{1-3}

Trench 4, Unit 1

PM 25642, right maxillary with M^{1-2}

WAM 74.9.5, right maxillary with P^4-M^3

Trench 4, Unit 1, Level 1

TMM 41106-556, left maxillary with M^{1-4}

Trench 4, Unit 2, Level 1

PM 25731, left maxillary fragment with M^1

PM 25738, right maxillary with M^{1-4}

WAM 74.9.6, left maxillary with M^1, M^{3-4}

PM 25740, left maxillary with M^{1-3}

PM 25741, right maxillary with M^{1-2}

PM 25742, left maxillary with M^{1-3}

PM 25743, right maxillary with M^{2-4}

PM 25746, right maxillary with P^4-M^1

TMM 41106-824, right maxillary with M^{1-4}

Trench 4, Unit 2, Level 2

PM 25607, left maxillary with P^4-M^4

Trench 4, Units 4-5

TMM 41106-701, left maxillary fragment with M^2

TMM 41106-703, right maxillary fragment with M^3

PM 25613, left maxillary with P^{3-4} (figs. 20C, D)

PM 25614, right maxillary fragment with M^1

PM 25619, left maxillary fragment with M^3

Opposite:

FIG. 20. *Antechinomys spenceri* from Madura Cave shown approximately × 8¼. **A, B.** PM 25799, L. maxillary with P^3, M^{1-4} shown in labial (A) and occlusal (B) views. **C, D.** PM 25613, L. maxillary with all premolars, shown in labial (C) and occlusal (D) views.

WAM 74.9.7, right maxillary fragment with M^3

PM 29458, left maxillary fragment with M^2

PM 29459, right maxillary fragment with M^3

PM 29460, right maxillary fragment with M^2

Trench 5, Unit 5

PM 25632, right mandible edentulous

We have available for comparison eight modern specimens of *Antechinomys* (*A. laniger* MVZ 133197 through 133202; *A. spenceri* MVZ 134276, AMNH 15012, fig. 18). When their dental measures are added to the scatter diagrams (figs. 4-7), they show that, in general, the modern representatives of these species are slightly smaller than the Madura fossil *A. spenceri*.

This is the case for P_2 and P_3, where one P_2 and one P_3 of the modern *A. spenceri* specimens, and one P_3 of the *A. laniger* specimens, fall just within the clouds of points for the Madura fossils assigned to *A. spenceri*. All other P_{2-3} of the modern *A. spenceri* and *A. laniger* are still smaller, falling just outside the clouds, within the area of the fossil *Sminthopsis murina* teeth (fig. 5). The P_4's of the fossils are slightly broader than those of either of the modern representatives, but the modern *A. spenceri* tooth is slightly longer than any of the fossils, and the modern *A. laniger* teeth are at the lower end of the range for both dimensions.

The clouds of points representing the lower molars of the Recent *A. laniger* sample overlap the short, narrow end of the clouds of the Madura Cave *Antechinomys* sample. Both *A. spenceri* specimens fall well within the cloud for M_2 but adjacent to it for M_3. For M_1 and M_4, in each case one specimen plots within the cloud and one outside, on the narrow side. The M_4 that falls outside is also the longest tooth of the lot.

Description. — The mandible of the Madura Cave *Antechinomys* has the general form seen in most of the small dasyurids. The horizontal ramus is slender and tapers anteriorly (fig. 19). The ventral margin is gently convex, but there is a tendency for the portion anterior to P_3 to be flattened, giving a slightly concave appearance to this section of the mandible. The mental foramen lies under the M_1. The symphysial joint is ligamental. It extends from the anterior end of the horizontal ramus to a position between P_3 and P_4.

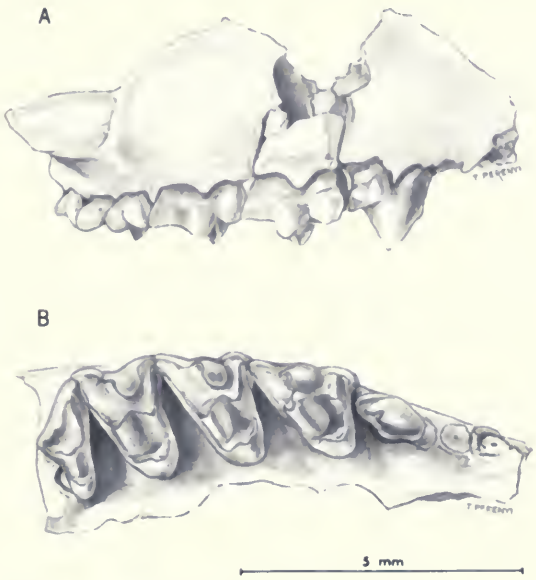


FIG. 21. *Antechinomys spenceri* from Madura Cave shown approximately × 8½. PM 25798, R. maxillary with P^4-M^4 in labial **(A)** and occlusal **(B)** views.

The posterior part of the mandible has a number of features that distinguish *Antechinomys* from *Sminthopsis*. The anterior border of the ascending ramus is more inclined posteriorly than in the species of *Sminthopsis* we have examined. In most specimens of *Antechinomys* it is slightly concave anterodorsally. The coronoid process is turned strongly posteriorly in most specimens in which it is preserved. The articular process of the condyle is flat and slightly inclined forward and medially. It is almost rectangular (the lateral end is slightly wider than the medial), with the long axis being transverse to the plane of the ramus. It is located higher above the tooth row than in *Sminthopsis*. This high position of the condyle and the more posterior inclination of the anterior edge of the ascending ramus results in a masseteric fossa that is narrower than in *Sminthopsis*. Its front and back edges are more nearly parallel rather than flaring upward as they do in *Sminthopsis*.

The angular process of *Antechinomys* is inflected at about 45° and is very long and greatly arched to extend under the large auditory bulla. This, and the relatively high position of the condyle, result in the condyle being located closer to the end of the coronoid process rather than being equidistant between the coronoid and angular processes, as in *Sminthopsis*.

The mandibular foramen is small and is located close to the midline of the ascending ramus at or below the level of the teeth.

None of the fossil jaw rami preserve the lower incisors or canine teeth. Alveoli of the incisors are weakly oval (higher than broad), and crowded. That of the canine is elongate and oval, the long dimension being about the combined length of the P_2 alveoli lying immediately behind it.

The premolars are small, elliptical in crown view, with one major anteriorly-placed cusp each. This main cusp in unworn teeth turns slightly lingually near its tip. The P_3 is the largest of the premolars. P_2 and P_4 are approximately the same size with the P_4 tending to be somewhat wider.

The long axis of the P_4 is oriented parallel to that of the other teeth in most specimens, but its posterior end lies labial to the anterior end of the M_1. The degree of overlap is variable.

All of the premolars have well-developed posterior cingula which in P_3 and P_4 have small cuspules. The P_3 and P_4 also have smaller anterior cingula which may or may not be connected to the posterior ones labially or lingually.

The molars all have high trigonids that are dominated by the protoconid. The paraconid is weakest and lowest on M_1. In all molars except M_4 the metaconid is the second largest trigonid cusp, and the paraconid shows a progressive increase in size from M_1 to M_4 so that in M_4 paraconid and metaconid are subequal. Crests connect protoconid to paraconid [paracristid (I′)] and to metaconid [epicristid (II′ and I_a‴)] across V-shaped valleys that initially have a weak cleft (carnassial notch) and groove at the bottom. Wear may quickly erase this feature, but it usually persists longer on the paracristid than in the epicristid, except in M_1 in which the paracristid is poorly developed.

Viewed from above, the epicristid is oriented transverse to the long axis of the tooth and jaw ramus in $M_{2\text{-}4}$, and the paracristid lies at about a 35-40° angle from this (with the angle centered on the protoconid). In M_1 the corresponding angle is much wider (60-70°), and the epicristid, instead of having a transverse orientation as in $M_{2\text{-}4}$, runs diagonally posteromedially at about 15-25° from the transverse axis. The paracristid runs diagonally anteromedially at about 30-45° from the long axis. In unworn teeth, a valley lies diagonally across the floor of the trigonid from the bottom of the V

in the paracristid to the gap between paraconid and metaconid. With progressive wear, the center of the trigonid becomes smoothly basined. Each trigonid is situated over the anterior root.

The talonids are broad and low, lower than the trigonids, and located above the posterior root in each case. They are dominated by the hypoconids, which are so formed that their anteromedially- and posteromedially-directed crests form V's in an *en echelon* arrangement behind and below those of the protoconids. The talonids are basined initially and remain so until extreme wear causes their posterior crests (*post-cristids*) to be breached, thus opening the basins to the interdental spaces. Entoconid development varies from small to absent. When present, it lies at the extreme medial edge of the tooth and is usually elongated. It is connected by a weak crest to the metaconid and usually also to the hypoconulid. The hypoconulids are distinct and well formed. Each projects backward so as to interlock between the parastylid and medial end of the anterior cingulum of the next tooth. In old individuals with extremely worn teeth, they become reduced. The posterior crest from the hypoconid runs nearly to the medial edge of the tooth before turning sharply to join the hypoconulid. At the point of inflection it joins a variably-developed, short, diagonal crest which trends inward toward the center of the talonid basin.

Stout anterior and posterior cingula commence low on the labial side of the front and back edges of each tooth (except rear of M_4). They rise as they cross the tooth towards the medial corners. There is some variation in development of the anterior cingulum and the parastylid, but the usual pattern is as described above in the discussion of the hypoconulid.

The talonid of M_4 is narrow and elongate with a single dominant posterior cusp, the hypoconid, at the back. The hypoconid is connected to the base of the metaconid (and epicristid) by a low crest, cristid obliqua, that runs from its apex obliquely forward across the talonid. Traces of hypoconulid and entoconid may or may not be present, and they are readily removed by wear, as can be the cristid obliqua. In crown view M_1 and M_2 are always tapered; narrower in front, wider behind. In M_3 the two moieties are about equal, and in M_4 the taper is sharp in the posterior direction.

Maxillaries and Upper Dentitions

The description is based on PM 25613, WAM 74.9.5 and .6, PM 25741, PM 25771, PM 25798, PM 25799, and TMM 41106-824,

except as otherwise noted. No specimen has the entire maxillary preserved, but taken together the materials allow the reconstruction of all of the maxillary except for part of the palate and that portion dorsal to the infraorbital foramen (figs. 20, 21).

The size of the infraorbital foramen is fairly constant, but its shape varies from an elongate double opening in PM 25771 and TMM 41106-824 to a single opening in WAM 74.9.5. Most of the other specimens show an intermediate condition, and two of them, PM 25741 and PM 25613, have a tiny groove that runs anteriorly from the main opening for a short distance, then leads into a small foramen which runs forward within the bone. In WAM 74.9.6, where a break goes through the area of the P^4, it can be seen that this canal branches. One branch is directed ventrally into the palatal part of the bone. The other follows along the base of the roots of the teeth. In PM 25771 this dorsal branch of the canal can be followed all the way to the alveolus of the canine. These canals are for the alveolar nerves and blood vessels. In the Recent specimens available to us, the infraorbital foramen is variable but tends to be doubled.

Specimen PM 25613 preserves two sutures, that for the premaxillary, which has a tongue and groove structure, and a portion of that for the lacrimal. Specimen PM 25771 shows that the posterior margin of the anterior palatine foramen lies opposite the middle of the first premolar. The large palatal vacuity can be traced from the posterior root of P^4 at least as far posteriorly as the posterior edge of M^2, where breakage makes its limit uncertain.

No specimen has the canine preserved, and PM 25613 is the only specimen with three premolars preserved. There is considerable variation in the size of P^3 and P^4. All the premolars are more massive, especially basally, than the premolars of *Sminthopsis*. Each has a central cusp that is rounded in front and crested behind. A small cingulum is present on the front part of each tooth, from the lingual side of the anterior root around the front edge to the labial side of the tooth where it becomes very weak between the roots. From this point it rapidly enlarges to form a prominent posterior cusplet. The cingulum disappears on the lingual side of the posterior root.

The premolars increase in size from front to back with P^2 and P^3 being subequal. In specimen PM 25613 all three teeth show heavy wear along their posterior edges from the tips of the main cusps to the backs of the teeth.

There are four specimens with complete molar series, PM 25771, PM 25793, PM 25799, and TMM 41106-824. As stated above, the molars are similar to those of *Sminthopsis*, especially *S. murina*, but they differ in their width measures primarily in the area of the stylar shelf. This is most readily seen in those scatter diagrams of M^2 that involve the anterior and posterior segments of the eocrista (parastyle-paracone width and metastyle-metacone width) and the anterior and posterior widths of the teeth (figs. 9A, C; 10B, D-F).

The notch on the ectoloph between the stylocone and cusp C (Bensley, 1903) is generally bordered by a straight or slightly-curved anterior shoulder (fig. 21B). Specimens PM 25799 and TMM 41106-824 are exceptional in having the strongly-curved anterior shoulders characteristic of *Sminthopsis*. The posterolingual face of the protocone may or may not have a wear facet. In those specimens in which it does occur, it is not thegosed. The angle formed by the ectoloph and the anterior edge of the tooth tends to be appreciably greater than 90° in *Antechinomys*, in contrast to the situation in *Sminthopsis* in which it is very close to 90°.

Discussion. — *Antechinomys spenceri* is widely distributed in the arid regions of Western Australia, South Australia, and the Northern Territory. This includes at least part of the Nullarbor Plain with a record from Rawlinna (Troughton, 1962). Its continuous presence in the Nullarbor Plains area through the late Pleistocene and post-Pleistocene indicates the presence of open areas throughout this period of time. The minor morphological differences noted here between the fossil material and the Recent specimens suggest that there have been small evolutionary changes over this period of time.

INCERTAE SEDIS

Eight specimens, each displaying distinct morphologic features, had to be included here because neither tooth measurements nor other features allowed their unequivocal assignment.

Trench 4, Unit 2, Level 2

PM 25601, left ramus fragment with M_{1-2}. Probably *Antechinomys spenceri* since most dental measures plot within the range of the other specimens of that taxon, but the plot for M_2 of trigonid length versus trigonid width is intermediate between those of *Sminthopsis murina* and *A. spenceri*.

PM 25706, left ramus with M_{2-3}. Probably *A. spenceri,* but both trigonid length versus trigonid width plots (M_2 and M_3) are intermediate between those of *A. spenceri* and *S. murina,* while the other measures give plots that fall within those of *A. spenceri.*

PM 25709, left ramus fragment with M_2. Probably *S. murina* as the plot of length versus anterior width indicates, but that for trigonid length versus trigonid width is intermediate between those for *S. murina* and *A. spenceri.*

TMM-41106-690, isolated lower molar. Probably *S. murina* since most measures plot with those of *S. murina,* but they are frequently quite far off to one side (long trigonid).

Trench 4, Units 4-5

PM 25617, right maxillary fragment with P^4 and M^4
PM 25618, right maxillary fragment with P^4
PM 25622, left maxillary fragment with M^4

} Probably *Sminthopsis* or *Antechinomys,* but possible *Antechinus.*

Trench 4, Unit 7

PM 25626, right ramus fragment with M_1. Some of the bivariate plots are intermediate between *S. murina* and. *A. spenceri.*

Included among the sieving concentrates are hundreds of isolated phascogaline teeth and edentulous ramal and maxillary fragments. Those which we believe to belong to the three taxa covered by this section of the Madura Cave fauna are listed by trench and level:

Trench 1, Top 30″

PM 26167

Trench 3, Unit 2

PM 25782, PM 25789, PM 25794

Trench 3, Unit 2, Level 4

TMM-41106-152

Trench 3, Unit 3

TMM-41106-53, PM 26133

Trench 4, Unit 1, Top 1′

PM 25637-8, PM 25640-1, PM 26280, TMM-41106-555, TMM-41106-756, TMM-41106-758-9

Trench 4, Unit 2, Level 1

PM 25720

Trench 4, Unit 2, Level 2

PM 25712, PM 26286 through PM 26302, TMM-41106-757, TMM-41106-762, TMM-41106-779, TMM-41106-823, and one uncatalogued bulk lot

Trench 4, Unit 2, Level 3

PM 25634, TMM-41106-780 through 784

Trench 4, Units 4-5

PM 25544, PM 25608, PM 25623, PM 26281 through 26285, TMM-41106-19 (a bulk lot with over 100 isolated teeth), TMM-41106-763A and B through 778, TMM-41106-788-9, TMM-41106-790-822, two uncatalogued edentulous rami, and an uncatalogued bulk lot with approximately 50 teeth and 25 jaws.

Trench 4, Unit 7

PM 25625 and an uncatalogued bulk lot with dozens of isolated teeth and six edentulous jaw fragments

Trench 5, Unit 5

1 uncatalogued ramus fragment

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REFERENCES

ARCHER, M.

1972. Nullarbor 1969. Western Caver, **12,** no. 1, pp. 17-24

BENSLEY, B. A.

1903. On the evolution of the Australian Marsupialia; with remarks on the relationships of the marsupials in general. Trans. Linnean Soc., London, ser. 2, **9,** Zool., pp. 83-216, figs. 1-6, pls. 5-7.

EVERY R. G. AND W. G. KUHNE

1970. Funktion und form der Säugerzahne I Thegosis, Usur and Druckuser. Z. Säugetierk, **35,** no. 4, pp. 247-252.

GOULD, J.

1844. Exhibition and character of a number of animals, etc., Transmitted from Australia by Mr. Gilbert. Proc. Zool. Soc., London, Part XII, pp. 103-105.

KREFFT, G.

1867. On the classification of the small *Dasyuridae* of Australia, with descriptions of two new genera and one new species. Proc. Zool. Soc., London, **1866,** pp. 431-435, pl. XXXVI.

LUNDELIUS, F. L., JR.

1957. Additions to knowledge of the ranges of Western Australian mammals. W. Austral. Natur., **5,** no. 7, pp. 173-182.

1963. Vertebrate remains from the Nullarbor Caves, Western Australia. Jour. Roy. Soc. W. Austral., Perth, **46,** no. 3, pp. 75-80.

LUNDELIUS, E. L., JR. and W. D. TURNBULL

1973. The mammalian fauna of Madura Cave, Western Australia, Part 1. Fieldiana: Geol., **31,** no. 1, pp. 1-35, figs. 1-13.

MARLOW, B.

1962. Marsupials of Australia. Jacaranda Pocket Guides, Jacaranda Press, Brisbane, 141 pp.

THOMAS, O.

1888. Catalogue of the Marsupialia and Monotremata in the collection of the British Museum (Nat. Hist.). Taylor & Francis, London, i-xiii, 1-401 pp., I-XXVIII pls.

1906. New mammals from the Australian region. Ann. Mag. Nat. Hist., Ser. 7, **17**, pp. 324-332.

TROUGHTON, E.

1962. Furred animals of Australia (7th ed.). Angus & Robertson, Sydney, London, Melbourne & Wellington, i-xxxii + 1-376 pp.

1964. Review of the marsupial genus *Sminthopsis*. Proc. Linn. Soc. New South Wales, 1964, **89**, pt. 3, pp. 307-321, figs. 1-7.

TURNBULL, W. D.

1971. The Trinity therians: their bearing on evolution in marsupials and other therians, pp. 151-179. *In* Dahlberg, A. A., ed., Dental morphology and evolution, Univ. of Chgo. Press, Chicago, 350 pp.

VANDEBROEK, G.

1961. The comparative anatomy of the teeth of lower and nonspecialized mammals. Intl. Colloq. Evol. Mammals. Kon VI. Acad. Wetensch. Lett. Sch. Kunsten Belgie, Brussels. Pp. 215-320 (part 1); pls. 1-44 (part 2).

1964. Récherches sur l'origine des mammiféres. Ann. Soc. Roy. Zool. Belg., **94**, pp. 117-160.

WATERHOUSE, G. R.

1838. Catalogue of the Mammalia preserved in the museum of the Zoological Society, 2nd ed. Richard & John E. Taylor, London, 68 pp.

APPENDIX 1

Specimen List for Figure 2

Sminthopsis murina Wedges Cave N = 25; PM 4235 through 4237, PM 4240-1, PM 4243-4, PM 4246 through 4260, PM 4262-3, and PM 4265.

S. murina Hastings Cave N = 41; PM 16559, PM 16562, PM 16565, PM 16568-9, PM 16576 through 16582 (PM 16581 is shown in fig. 17 A-B).

S. "hirtipes" (= *S. murina*) W.A.M. Recent N = 2; M 1547, M 1577.

S. murina Madura Cave fossils N = 5; only one specimen, PM 25532, gave both measurements while in four others, WAM 72.3.11-12, PM 25791, and TMM 41106-479, P_4 was measured but only a minimal estimate of the molar series was possible, and, finally, three others afforded only the latter estimate, PM 25635, PM 25791, and PM 25793.

S. murina W.A.M. and U.S.A. Recent N = 34 (30 WAM, 3 MVZ, 1 TMM); M 4, M 81, M 286, M 662, M 709, M 981, M 1005-6, M 1177, M 1231, M 1314, M 1333, M 1564, M 1674, M 1714, M 1758, M 1835-6, M 1841, M 1945, M 1960, M 1969, M 2059, M 2193, M 2263, M 2345, M 2401, M 2453, M 2534, M 7384; MVZ 133183-4, MVZ 133342; and TMM M-840.

S. rufigenis lumholtzi AMNH N = 9; 154479 through 154487 (2 juveniles lacked erupted P_4's).

S. larapinta MVZ Recent N = 5; 133173, 133188, 133190 through 133192.

S. granulipes W.A.M. N = 3; M 1397, M 1968, M 2333.

S. crassicaudata Murraèlellevan Cave N = 10; PM 4128, PM 4130-1, PM 4133 through 4138, and PM 4157.

S. crassicaudata W.A.M. Recent N = 33; M 549, M 564, M 670, M 690, M 799, M 911-2, M 1011, M 1015, M 1031, M 1055-6, M 1140, M 1157, M 1174, M 1278, M 1387, M 1565, M 1676, M 1735, M 1764, M1830, M 1965, M 2275, M 2277, M 2283, M 2286, M 2290, M 2413, M 2413*, M 2452, M 2560, and M 2624.

S. crassicaudata Recent USA N = 7; FMNH 34722 through 34724, 60116, 104788, TMM M-839, and AMNH 160032.

S. crassicaudata Madura Cave fossils N = 6; PM 25525, PM 25534-5, and PM 25537 each gave both measures, while WAM 72.3.8, PM 25528-25529 each gave one measure only.

Antechinomys laniger MVZ N = 5; MVZ 133197, MVZ 133199 through 133202.

A. spenceri Murraelellevan Cave N = 16; PM 4140 through 4147, PM 4150 through 4156, and PM 4158.

A. spenceri W.A.M. and other N = 7; M 1546, M 2230, and M 2368, BMNH 5.5.3.3, BMNH 15.2.22.6, AMNH 15012, MVZ 134276.

A. cf. *spenceri* Madura Cave fossils N = 22; (17 specimens gave both measures, 13 gave one or the other as follows): **Both** TMM 41106-123, 41106-126, 41106-128-129, 41106-325, 41106-520, and PM 25533, PM 25536, PM 25605, PM 25717-25718, PM 25721, PM 25724, PM 25735, PM 25754, PM 25762, and PM 25775; **P_4 only** PM 25770, PM 25780, PM 25785, WAM 72.3.18, and PM 26159; **with M_{1-4}** only PM 25598, PM 25716, PM 25719, PM 25763, PM 25769, PM 25776-25777, and PM 26160.

*Different data – probably recording error in specimen number

APPENDIX 2

Specimen List for Figure 3A

Sminthopsis rufigenis lumholtzi AMNH 154479 through 154487.

S. larapinta MVZ - University of California 133173, 133188, 133190 through 133192. Plotted with a flag is AMNH 108934 labelled *Sminthopsis macrura* but which plots with *Sminthopsis larapinta.*

S. stalkeri MVZ - University of California 134305.

S. macrura MVZ - University of California 134244.

S. crassicaudata Recent sample TMM M-839, AMNH 160032, 196685, FMNH 34722 through 34724, 60116, and 104788.

S. crassicaudata (Madura Cave) PM 25525, WAM 72.3.8, PM 25528 through 25530, PM 25534-25535, and PM 25537 and TMM 41106-755, all from Unit 1; and 41106-521 and WAM 72.3.9 from Unit 2.

APPENDIX 3

Specimen List for Figure 3B

Sminthopsis psammophila South Australia Museum M 7971.

S leucopus R. H. Green private collection, Registered #19/1 (Queen Victoria Museum).

S. hirtipes? MVZ 133187.

S. murina Hastings Cave fossil PM 16559, PM 16562, PM 16565, and PM 16568 through 16582.

S. murina fuliginosa MVZ 133342, TMM M-840.

S. murina murina, MVZ 133183-133184.

S. murina (Madura Cave) TMM 41106-479, PM 25269, PM 25532, PM 25600, PM 25606, PM 25629, PM 25635-25636, PM 25711, PM 25714-25715, PM 25737, WAM 72.3.11, PM 25757, WAM 72.3.12, PM 25791, and PM 25793.

APPENDIX 4

Specimen List for Figure 4

Antechinomys spenceri AMNH 15012, MVZ, U. of California 134276.

A. laniger MVZ 133197 through 133202.

A. spenceri Madura TMM 41106-120-121, WAM 72.3.16, TMM 41106-123 through -126, TMM 41106-128 through -131, TMM 41106-325, PM 25527, PM 25533, PM 25536, PM 25598-25599, PM 25603, PM 25605, PM 25628, PM 25716 through 25719, WAM 72.3.20, PM 25727 through 25730, PM 25732 through 25735, WAM 74.9.2, PM 25747, PM 25754 through 25756, PM 25759 through 25770, PM 25772, PM 25775 through 25781, WAM 72.3.17, PM 25785 through 25786, PM 25790, WAM 72.3.18 and 19. PM 26153, PM 26156 through PM 26161, PM 26166, and PM 26305.

APPENDIX 5

Specimen List for Figure 5

Sminthopsis murina TMM 41106-479, PM 25532, PM 25606, WAM 72.3.11 and 12, PM 25791, and PM 25793.

Antechinomys spenceri TMM 41106-120-121, WAM 72.3.16, TMM 41106-126, TMM 41106-128 through -131, TMM 41106-325, TMM 41106-520, PM 25533, PM 25536, PM 25605, PM 25716 through 25719, WAM 72.3.20, PM 25733 through 25735, PM 25754, PM 25760, PM 25762 through 25763, PM 25767, PM 25770, PM 25775, PM 25779 through 25780, PM 25785, WAM 72.3.18, PM 26159, and PM 26166.

APPENDIX 6

Specimen List for Figure 6

Sminthopsis murina WAM 72.3.12, PM 25791, and PM 25793.

Antechinomys spenceri TMM 41106-120-121, 123, WAM 72.3.16, TMM 41106-125-126, TMM 41106-128 through -130, TMM 41106-325, PM 25598, PM 25603, PM 25605, PM 25716 through 25719, WAM 72.3.20, PM 25728, PM 25730, PM 25732, PM 25734 through 25735, WAM 74.9.2, PM 25754 through 25756, PM 25762 through 25764, PM 25766 through 25767, PM 25769, PM 25775 through 25779, PM 25785 through 25786, WAM 72.3.18 and 19, PM 26153, PM 26156 through 26160, and PM 26305.

APPENDIX 7

Specimen List for Figure 7

Sminthopsis murina PM 25600, PM 25635, PM 25711, WAM 72.3.13, PM 25715, PM 25737, WAM 72.3.11, PM 25757, WAM 72.3.12, PM 25791, and PM 25793.

Antechinomys spenceri TMM 41106-120-121, 123, WAM 72.3.16, TMM 41106-125-126, TMM 41106-128 through -130, TMM 41106-325, PM 25598, PM 25603, PM 25605, PM 25716 through 25719, WAM 72.3.20, PM 25728, PM 25730, PM 25732, PM 25734 through 25735, WAM 79.9.2, PM 25754 through 25756, PM 25762 through 25764, PM 25766 through 25767, PM 25769, PM 25775 through 25779, PM 25785 through 25786, WAM 72.3.18 and 19, PM 26153, PM 26156 through 26160, and PM 26305.

APPENDIX 8

Specimen List for Figures 9, 10

Sminthopsis crassicaudata WAM 72.3.10, PM 25604, PM 25620, PM 25630, and PM 25744.

S. murina PM 25531, PM 25745, WAM 72.3.14, PM 25797, PM 26140, PM 26148, TMM 41106-480, and TMM 41106-761.

Antechinomys spenceri TMM 41106-139, TMM 41106-556, TMM 41106-701, TMM 41106-824, PM 25607, PM 25642-3, PM 25738, PM 25740 through 25743, PM 25748-9, PM 25771, PM 25796, PM 25798-9, PM 26141 through 26143, PM 26145, PM 26147, and PM 26149-50.

APPENDIX 9

Statistical Tables

TABLE 1. Statistical data on upper dentitions of *Sminthopsis crassicaudata* from Madura Cave.

		N	Observed Range	Mean
M^1	L	2	1.67-1.75	1.71
	AW	2	1.25-1.37	1.31
	PW	2	1.82	1.82
	PSW	2	.61—.70	.66
	MSW	2	1.29-1.41	1.35
	PSW + MSW	2	1.99-2.02	2.00
M^2	L	4	1.62-1.67	1.64
	AW	4	1.52-1.67	1.58
	PW	4	1.98-2.13	2.04
	PSW	4	.89—.99	.94
	MSW	4	1.46-1.56	1.50
	PSW + MSW	4	2.37-2.55	2.44
M^3	L	5	1.44-1.65	1.52
	AW	5	1.71-1.84	1.77
	PW	4	1.92-2.13	2.05
	PSW	5	1.10-1.23	1.18
	MSW	5	1.44-1.56	1.50
	PSW + MSW	5	2.54-2.79	2.68

TABLE 2. Statistical data on lower dentitions of *Sminthopsis crassicaudata* from Madura Cave units 1 and 2.

		N	Observed Range	Mean
LM_{1-4}		3	5.76-6.02	5.91
Distance - ant. end P_4 to ant. end M_1		3	.68—.79	.73
P_2	L	4	.91—.96	.95
	W	4	.48—.56	.53
P_3	L	2	1.12-1.17	1.15
	W	2	.61—.66	.64
P_4	L	4	.94-1.12	1.02
	W	4	.51—.56	.53
M_1	L	4	1.44-1.52	1.48
	AW	4	.73—.76	.75
	PW	4	.79—.81	.80
M_2	L	4	1.47-1.67	1.58
	AW	4	.81—.96	.90
	PW	4	.89—.99	.96
M_3	L	3	1.52-1.72	1.64
	AW	3	1.01-1.08	1.03
	PW	3	.86—.99	.94
M_4	L	5	1.47-1.62	1.57
	AW	5	.91—.99	.95
	PW	5	.30—.46	.38

TABLE 3. Statistical data on upper dentitions of two Recent samples of *Sminthopsis crassicaudata*.

		Material available in U.S. from Western Australia and South Australia			Material in Western Australian Museum (Sample from Western Australia)				
		N	Observed Range	Mean	N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
M^{1-4}	L	8	5.02-5.37	5.12	33	4.95-5.36	5.16 ± .02	.10	1.99
M^{1-3}	L	8	4.31-4.76	4.46	33	4.25-4.70	4.49 ± .02	.09	2.07
P^2	L	8	.80---.95	.90	—	—	—	—	—
	W	8	.36---.49	.44	—	—	—	—	—
P^3	L	8	.91-1.06	1.03	—	—	—	—	—
	W	8	.46---.57	.50	—	—	—	—	—
P^4	L	8	.95-1.18	1.10	33	.93-1.15	1.04 ± .01	.06	5.59
	W	8	.53---.65	.58	—	—	—	—	—
M^1	L	8	1.60-1.75	1.67					
	AW	8	1.03-1.18	1.10					
	PW	8	1.75-1.90	1.80					
	PSW	8	.49---.61	.57					
	MSW	8	1.29-1.52	1.38					
	PSW+MSW	8	1.86-2.05	1.95					
M^2	L	8	1.46-1.61	1.55					
	AW	8	1.44-1.56	1.50					
	PW	8	1.95-2.22	2.07					
	PSW	8	.81---.98	.88					
	MSW	8	1.46-1.63	1.52					
	PSW+MSW	8	2.29-2.51	2.40					

TABLE 3. — *continued.*

Material available in U.S. from Western Australia and South Australia

		N	Observed Range	Mean
M^3	L	8	1.35-1.48	1.41
	AW	8	1.63-1.81	1.71
	PW	8	1.94-2.09	2.01
	PSW	8	1.10-1.24	1.16
	MSW	8	1.41-1.52	1.47
	PSW+MSW	8	2.53-2.76	2.63
M^4	L	8	.72---.87	.78
	AW	8	1.67-1.82	1.74

TABLE 4. Statistical data on lower dentitions of two Recent samples of *Sminthopsis crassicaudata*.

		Material available in U.S. from Western Australia and South Australia.			Material in Western Australian Museum (Sample from Western Australia)				
		N	Observed Range	Mean	N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
L	M_{1-4}	7	5.51-5.73	5.63	33	5.50-5.91	5.67 ± .02	.12	2.08
Dist. ant. end of P_4 to ant. end of M_1		6	.80---.91	.86	33	.61---.93	.81 ± .01	.08	9.43
P_2	L	8	.76---.99	.91	—	—	—	—	—
	W	8	.46---.51	.49	—	—	—	—	—
P_3	L	8	.95-1.17	1.09	—	—	—	—	—
	W	8	.51---.59	.56	—	—	—	—	—
P_4	L	6	.93-1.06	.99	33	.78-1.04	.92 ± .01	.06	6.09
	W	6	.46---.54	.50	—	—	—	—	—
M_1	L	7	1.32-1.47	1.39					
	AW	7	.63---.72	.68					
	PW	7	.71---.81	.76					
M_2	L	8	1.42-1.62	1.52					
	AW	8	.86---.98	.90					
	PW	8	.81---.94	.89					
M_3	L	8	1.45-1.61	1.53					
	AW	8	.96-1.06	.99					
	PW	8	.81---.91	.87					
M_4	L	8	1.47-1.67	1.52					
	AW	8	.89-1.02	.94					
	PW	8	.28---.48	.38					

TABLE 5. Statistical data on upper dentitions of *Sminthopsis murina* from Madura Cave.

		N	Observed Range	Mean
M^1	L	6	1.61-1.79	1.70
	AW	6	1.10-1.31	1.20
	PW	6	1.79-1.94	1.87
	PSW	6	.53---.66	.62
	MSW	6	1.31-1.48	1.41
	PSW + MSW	6	1.96-2.09	2.02
M^2	L	8	1.56-1.71	1.63
	AW	8	1.51-1.63	1.56
	PW	8	2.05-2.17	2.09
	PSW	8	.91-1.03	.97
	MSW	8	1.50-1.63	1.57
	PSW + MSW	8	2.47-2.63	2.54
M^3	L	5	1.29-1.52	1.43
	AW	5	1.65-1.82	1.77
	PW	5	1.86-2.09	1.98
	PSW	5	1.18-1.27	1.22
	MSW	5	1.29-1.56	1.45
	PSW + MSW	5	2.54-2.75	2.67
M^4	L	1		.72
	AW	1		1.71
	PW	1		1.25

TABLE 6. Statistical data on lower dentitions of *Sminthopsis murina* from Madura Cave.

		N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
P_2	L	2	.91---.94	.93	—	—
	W	2	.51---.56	.54	—	—
P_3	L	3	1.12-1.22	1.17	—	—
	W	3	.56---.58	.57	—	—
P_4	L	2	.92---.97	.95	—	—
	W	2	.48---.56	.52	—	—
M_1	L	1		1.52	—	—
	AW	1		.81	—	—
	PW	1		.89		
M_2	L	1		1.67	—	—
	AW	1		1.04	—	—
	PW	1		.96	—	—
M_3	L	4	1.57-1.72	1.67	—	—
	AW	4	1.06-1.12	1.09	—	—
	PW	5	.86---.96	.89	—	—
M_4	L	10	1.52-1.77	1.63 ± .02	.07	4.59
	AW	11	.86-1.06	.98 ± .02	.06	6.34
	PW	9	.30---.46	.35 ± .02	.05	1.66

TABLE 7. Statistical data on upper dentitions of Recent samples of *Sminthopsis murina*.

		Sminthopsis murina murina (Material available in in US)			*Sminthopsis murina fuliginosa* (Material available in US)			*Sminthopsis murina fuliginosa* (Material in Western Australian Museum)				
		N	Observed Range	Mean	N	Observed Range	Mean	N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
M^{1-4}	L	2	5.02-5.25	5.14	1		5.52	30	5.12-5.72	5.45 ± .03	.18	3.24
M^{1-3}	L	2	4.33-4.61	4.47	2	4.77-4.87	4.82	30	4.29-5.02	4.74 ± .03	.19	3.95
P^2	L	2	.80	.80	2	.87-1.06	.97	—	—	—	—	—
	W	2	.46	.46	2	.46	.46	—	—	—	—	—
P^3	L	2	.95---.99	.97	2	1.14-1.22	1.18	—	—	—	—	—
	W	2	.57---.61	.59	2	.61	.61	—	—	—	—	—
P^4	L	2	1.18-1.25	1.22	1		1.25	30	.80-1.31	1.15 ± .02	.10	9.04
	W	2	.57---.65	.61	1		.65	—	—	—	—	—
M^1	L	2	1.63-1.67	1.65	2	1.82	1.82					
	AW	2	1.14	1.14	2	1.14-1.22	1.18					
	PW	2	1.71-1.75	1.73	2	1.82-1.90	1.86					
	PSW	2	.57---.61	.59	2	.49---.57	.53					
	MSW	2	1.29-1.33	1.31	2	1.33-1.41	1.37					
	PSW+ MSW	2	1.86-1.94	1.90	2	1.82-1.98	1.90					

TABLE 7. — *continued.*

		Sminthopsis murina murina (Material available in in US)			*Sminthopsis murina fulginosa* (Material available in US)		
		N	Observed Range	Mean	N	Observed Range	Mean
M^2	L	2	1.46-1.59	1.53	2	1.68-1.71	1.70
	AW	2	1.51	1.51	2	1.46-1.54	1.50
	PW	2	1.93-1.95	1.94	2	1.93-1.98	1.96
	PSW	2	.88---.93	.91	2	.83-1.00	.92
	MSW	2	1.44-1.54	1.49	2	1.41-1.46	1.44
	PSW+ MSW	2	2.32-2.47	2.40	2	2.29-2.41	2.35
M^3	L	2	1.33-1.46	1.40	2	1.50-1.52	1.51
	AW	2	1.62-1.67	1.65	2	1.60-1.79	1.70
	PW	2	1.86-1.98	1.92	2	1.94-2.05	2.00
	PSW	2	1.14	1.14	2	1.10-1.25	1.18
	MSW	2	1.41	1.41	2	1.44-1.48	1.46
	PSW+ MSW	2	2.55	2.55	2	2.54-2.73	2.64
M^4	L	2	.76---.82	.79	2	.70---.76	.73
	AW	2	1.56-1.71	1.64	2	1.81-1.85	1.83

TABLE 8. Statistical data on lower dentitions of Recent samples of *Sminthopsis murina*.

	Sminthopsis murina murina (Material available in U.S.)			*Sminthopsis murina fuliginosa* (Material available in U.S.)			*Sminthopsis murina fuliginosa* (Material in Western Australian Museum)				
	N	Observed Range	Mean	N	Observed Range	Mean	N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
L M_{1-4}	2	5.53-5.89	5.71	2	6.09-6.38	6.24	30	5.58-6.35	5.98 ± .03	.18	3.08
Dist. ant. end of P_4 to ant. end of M_1	2	.87-1.00	.94	1		.95	30	.76-1.02	.91 ± .01	.08	8.54
P_2 L	2	.85---.95	.90	2	1.09-1.10	1.10	—	—	—	—	—
W	2	.49---.51	.50	2	.48---.49	.49	—	—	—	—	—
P_3 L	2	1.05-1.10	1.08	2	1.20-1.27	1.24	—	—	—	—	—
W	2	.54	.54	2	.56---.58	.57	—	—	—	—	—
P_4 L	2	.93-1.07	1.00	1		.98	30	.79-1.11	.99 ± .01	.08	8.10
W	2	.54---.56	.55	1		.49	—	—	—	—	—
M_1 L	2	1.37-1.46	1.42	2	1.56-1.62	1.59					
AW	2	.66	.66	2	.71---.73	.72					
PW	2	.78---.81	.80	2	.81---.88	.85					
M_2 L	2	1.51-1.61	1.56	2	1.71-1.72	1.72					
AW	2	.90---.95	.93	2	1.05-1.06	1.06					
PW	2	.85---.93	.89	2	.96-1.02	.99					
M_3 L	2	1.59-1.71	1.65	2	1.68-1.72	1.70					
AW	2	1.02-1.05	1.04	2	1.12-1.14	1.13					
PW	2	.76---.88	.82	2	.91---.98	.95					
M_4 L	2	1.56-1.66	1.61	2	1.61-1.62	1.62					
AW	2	.95-1.00	.98	2	.96-1.00	.98					
PW	2	.39---.41	.40	2	.28---.41	.35					

TABLE 9. Statistical data on upper dentitions of *Antechinomys spenceri* from unit 1, Madura Cave.

		N	Observed Range	Mean
M^1	L	3	1.79-1.83	1.80
	AW	3	1.25-1.34	1.28
	PW	3	2.01-2.09	2.04
	PSW	3	.66---.68	.67
	MSW	3	1.56-1.60	1.59
	PSW + MSW	3	2.22-2.28	2.26
M^2	L	3	1.63-1.68	1.65
	AW	3	1.63-1.71	1.68
	PW	3	2.17-2.38	2.28
	PSW	3	.95-1.06	1.00
	MSW	3	1.71-1.82	1.76
	PSW + MSW	3	2.70-2.88	2.76
M^3	L	2	1.51-1.52	1.52
	AW	2	1.82-1.85	1.84
	PW	2	2.12-2.20	2.16
	PSW	2	1.25-1.27	1.26
	MSW	2	1.61-1.71	1.66
	PSW + MSW	2	2.88-2.96	2.92
M^4	L	1		.76
	AW	1		1.68

TABLE 10. Statistical data on lower dentitions of *Antechinomys spenceri* from unit 1, Madura Cave.

		N	Observed Range	Mean
Dist. ant. end P_4 to ant. end M_1		3	.89-1.00	.94
P_2	L	2	1.06-1.12	1.09
	W	2	.56	.56
P_3	L	2	1.32-1.37	1.35
	W	2	.61---.66	.64
P_4	L	3	1.01-1.12	1.06
	W	3	.58---.61	.60
M_1	L	3	1.52-1.57	1.54
	AW	3	.74---.89	.80
	PW	3	.89-1.01	.94
M_2	L	4	1.52-1.75	1.60
	AW	4	1.02-1.12	1.08
	PW	4	1.04-1.12	1.09
M_3	L	3	1.49-1.67	1.56
	AW	3	1.12-1.22	1.17
	PW	3	1.01-1.09	1.05
M_4	L	3	1.52-1.67	1.57
	AW	3	.99-1.01	1.00
	PW	3	.41---.51	.46

TABLE 11. Statistical data on upper dentitions of *Antechinomys spenceri* from unit 2 Madura Cave.

		N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
M^1	L	11	1.71-1.92	1.80 ± .02	.06	3.34
	AW	11	1.24-1.44	1.33 ± .02	.06	4.27
	PW	11	1.90-2.15	2.05 ± .02	.08	3.88
	PSW	11	.61---.80	.69 ± .02	.06	9.13
	MSW	11	1.48-1.67	1.57 ± .02	.06	3.77
	PSW+ MSW	11	2.13-2.39	2.26 ± .02	.08	3.41
M^2	L	12	1.58-1.76	1.67 ± .02	.07	4.31
	AW	12	1.63-1.90	1.74 ± .02	.08	4.93
	PW	12	2.20-2.55	2.33 ± .03	.11	4.62
	PSW	12	.95-1.10	1.03 ± .01	.04	3.91
	MSW	12	1.71-1.90	1.78 ± .02	.06	3.64
	PSW+ MSW	12	2.70-2.92	2.81 ± .02	.08	2.74
M^3	L	12	1.41-1.60	1.51 ± .02	.06	3.96
	AW	12	1.78-2.05	1.92 ± .02	.08	4.33
	PW	12	2.13-2.32	2.24 ± .01	.05	2.34
	PSW	12	1.14-1.37	1.28 ± .02	.07	5.25
	MSW	12	1.54-1.84	1.67 ± .02	.07	4.47
	PSW+ MSW	12	2.82-3.10	2.95 ± .02	.09	2.96
M^4	L	4	.78---.95	.84	—	—
	AW	4	1.71-1.90	1.84	—	—

TABLE 12. Statistical data on lower dentitions of *Antechinomys spenceri* from unit 2, Madura Cave.

		N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
L	M_{1-4}	7	6.01-6.48	6.23	—	—
Dist. ant. end of P_4 to ant. end M_1		5	.93-1.01	.96	—	—
P_2	L	6	1.06-1.17	1.13	—	—
	W	6	.53---.58	.56	—	—
P_3	L	4	1.22-1.42	1.35	—	—
	W	4	.66---.71	.68	—	—
P_4	L	6	1.09-1.17	1.14	—	—
	W	6	.56---.66	.61	—	—
M_1	L	11	1.59-1.77	1.67 ± .02	.06	3.80
	AW	10	.81---.92	.87 ± .01	.04	4.38
	PW	10	.91-1.04	.98 ± .01	.04	4.64
M_2	L	11	1.57-1.77	1.67 ± .02	.07	4.42
	AW	11	1.06-1.18	1.13 ± .01	.05	4.12
	PW	11	1.04-1.17	1.10 ± .01	.04	3.87
M_3	L	12	1.57-1.77	1.65 ± .02	.06	3.58
	AW	14	1.14-1.24	1.20 ± .01	.03	2.38
	PW	13	.96-1.17	1.08 ± .02	.06	5.92
M_4	L	13	1.52-1.77	1.65 ± .02	.07	4.42
	AW	13	.96-1.12	1.04 ± .01	.05	4.68
	PW	13	.33---.51	.43 ± .01	.05	12.31

TABLE 13. Measurements of upper and lower teeth of *Antechinomys spenceri* from units 4-5, Madura Cave.

	PM 25614	PM 29458	PM 29460	TMM 41106-701	PM 25619	PM 25628	PM 29459	TMM 41106-703
	M^1	M^2	M^2	M^2	M^3	M^3	M^3	M_3
L	1.83	1.76	2.07	1.77	1.52	1.60	1.76	1.62
AW	1.29	1.68	2.07	1.71	1.93	1.98	2.20	1.22
PW	2.03	2.24	2.44	2.32	2.18	2.20	2.44	1.06
PSW	.71	1.05	1.22	1.05	1.27	1.33	1.46	—
MSW	1.51	1.71	1.93	1.68	1.62	1.60	1.85	—
PSW MSW	2.22	2.76	3.15	2.73	2.89	2.93	3.31	—

	PM 25613		
	P_1 or $_2$	P_3	P_4
L	.98	1.12	1.34
W	.71	.66	.54

TABLE 14. Statistical data on upper dentitions of Recent samples of *Antechinomys*.

	Antechinomys laniger (Material available in U.S.)			*Antechinomys spenceri* (Material available in U.S.)			*Antechinomys spenceri* (Material in Western Australian Museum and other museums)				
	N	Observed Range	Mean	N	Observed Range	Mean	N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
M^{1-4} L	5	5.05-5.44	5.24	1		5.40	10	5.25-5.74	5.48 ± .06	.19	3.49
M^{1-3} L	5	4.46-4.58	4.52	2	4.62-4.68	4.65	10	4.48-5.17	4.78 ± .08	.24	5.11
P^2 L	6	.80-1.04	.91	2	.93---.95	.94	—	—	—	—	—
W	6	.36---.47	.40	2	.42	.42	—	—	—	—	—
P^3 L	6	1.14-1.19	1.15	2	1.20-1.22	1.21	—	—	—	—	—
W	6	.47---.57	.52	2	.53	.53	—	—	—	—	—
P^4 L	6	1.17-1.32	1.22	1		1.29	7	1.13-1.46	1.29	—	—
W	5	.52---.65	.60	1		.65	—	—	—	—	—
M^1 L	6	1.58-1.71	1.67	2	1.71-1.79	1.75					
AW	5	1.14-1.30	1.23	2	1.33	1.33					
PW	5	1.81-2.05	1.90	2	2.01-2.09	2.05					
PSW	1		.57	2	.63---.66	.65					
MSW	1		1.41	2	1.56-1.60	1.58					
PSW+ MSW	1		1.98	2	2.19-2.26	2.23					

TABLE 14. — *continued.*

		Antechinomys laniger (Material available in U.S.)			*Antechinomys spenceri* (Material available in U.S.)		
		N	Observed Range	Mean	N	Observed Range	Mean
M^2	L	6	1.45-1.58	1.52	2	1.63	1.63
	AW	6	1.58-1.71	1.63	2	1.66-1.71	1.69
	PW	6	2.03-2.25	2.12	2	2.07-2.20	2.14
	PSW	1		.88	2	.98-1.07	1.03
	MSW	1		1.46	2	1.51-1.63	1.57
	PSW+ MSW	1		2.34	2	2.49-2.70	2.60
M^3	L	6	1.30-1.45	1.40	2	1.37	1.37
	AW	6	1.76-1.99	1.86	2	1.82-1.96	1.89
	PW	6	1.98-2.20	2.09	2	1.90-2.19	2.05
	PSW	1		1.14	2	1.33-1.48	1.41
	MSW	1		1.41	2	1.41-1.63	1.52
	PSW+ MSW	1		2.55	2	2.89-2.96	2.93
M^4	L	6	.67---.86	.76	1		.81
	AW	6	1.57-1.89	1.71	1		1.72

TABLE 15. Statistical data on lower dentitions of Recent samples of *Antechinomys*.

	Antechinomys laniger (Material available in U.S.)			*Antechinomys spenceri* (Material available in U.S.)			*Antechinomys spenceri* (Material in Western Australian Museum and other museums)				
	N	Observed Range	Mean	N	Observed Range	Mean	N	Observed Range	Mean ± Standard Error	Standard Deviation	Coefficient of Variation (%)
L M_{1-4}	5	5.57-5.94	5.81	2	6.04-6.19	6.12	10	5.93-6.36	6.16 ± .07	.23	3.91
Dist. ant. end of P_4 to ant. end of M_1	6	.78-1.09	.94	1	1.10	1.10	3	.93-1.05	1.00	—	—
P_2 L	6	.96-1.04	1.00	2	1.08-1.12	1.10	—	—	—	—	—
W	6	.44---.52	.49	2	.46---.54	.50	—	—	—	—	—
P_3 L	6	1.14-1.25	1.19	2	1.28-1.32	1.30	—	—	—	—	—
W	6	.57---.66	.60	2	.56---.63	.60	—	—	—	—	—
P_4 L	6	1.00-1.14	1.07	1		1.27	7	.98-1.26	1.09	—	—
W	6	.47---.60	.54	1		.56	—	—	—	—	—
M_1 L	5	1.37-1.55	1.45	2	1.57-1.62	1.60					
AW	6	.73---.80	.76	2	.76---.88	.82					
PW	5	.80---.91	.85	2	.91---.96	.94					
M_2 L	6	1.48-1.61	1.56	2	1.62-1.71	1.67					
AW	6	.98-1.08	1.01	2	1.06-1.14	1.10					
PW	6	.91-1.06	.98	2	1.04-1.06	1.05					
M_3 L	6	1.48-1.63	1.59	2	1.67-1.80	1.74					
AW	6	1.01-1.20	1.08	2	1.09-1.23	1.16					
PW	6	.83---.98	.90	2	.97-1.01	.99					
M_4 L	6	1.53-1.66	1.61	2	1.77-1.82	1.80					
AW	6	.96-1.06	.99	2	.96-1.03	1.00					
PW	6	.51-.62	.55	2	.33---.48	.41					